A HISTORY OF THE LOS ANGELES DISTRICT
U.S. ARMY CORPS OF ENGINEERS
1898 - 1965

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1898 - 1965

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By: Anthony F. Turhollow

U.S. Army Engineer District,

Los Angeles, 1975

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FOREWORD

For 200 years the U.S. Army Corps of Engineers has been part of the fiber of this Nation, serving the people of the United States in war and peace. For more than 100 years, the Corps has been active in what is now referred to as the Los Angeles District – a fascinating area of deserts, mountains, rich farm lands, rivers and ocean front, open country and densely populated regions which reaches from the Continental Divide to the Pacific Ocean, and from the Grand Canyon to Mexico.

This is the story of that activity, from the time of the earliest Corps of Engineers effort here until 1965. Formally, the U.S. Army Engineer District, Los Angeles, traces its history to December 31, 1898, but in these pages you will be taken back to the earliest explorations and surveys of this area by Engineer officers before the Mexican War.

This volume is the first ever to draw the history of the Los Angeles District together into a single publication. I am proud to present it to the reader, and I commend its author, Dr. Anthony F. Turhollow, and the many members of the Los Angeles District, past and present, who contributed to it for a job well done.

JOHN V. FOLEY
Colonel, CE
District Engineer

Preface

This study relates and assesses the constantly changing activities of a relatively unknown agency of the Federal government, the Los Angeles District, Corps of Engineers, U.S. Army. In concentrating on the history of projects in water resources, the study neglected to some extent many support administrative functions which occupy many of the staff of LAD. Also neglected were the contributions that architect engineers, suppliers, and construction contractors made to the varied programs of the District. A sincere effort has been made to record the significant activities of LAD as definitively as possible.

No project of this type can reach fruition without the assistance of countless individuals. Personnel of LAD cooperated to the fullest extent in making available pertinent materials in their collections. Their attitude reflected the leadership efforts of District Engineers – Colonels Norman E. Pehrson, Robert J. Malley, H. McK. Roper, Jr., and John V. Foley – in stressing the importance of the study. The Historical Program Committee, LAD, headed by Deputy District Engineers, Lieutenant Colonels S. J. Black, James Metalios and Robert H. Reinen and composed of representatives of the major components of the District – Lester Hall (Engineering Division), John Redfern (Construction Division), Masao Sugano (Comptroller), James Gould (Supply), John Houston (Real Estate), Beatrice Williams (Personnel), Jacob Greenfield (Office of Counsel), Sidney Chriqui and Bessi Nonaka (Office of Administrative Services), Jeannette Hargrave (Librarian) and Perry Hume Davis II (Public Affairs Office) – provided valuable leads to materials. The unflagging support of Davis, his predecessor Frank King, Eleanor McCarthy, Larry Hawthorne (Public Affairs Office) and Chriqui eased considerably the tedious, but interesting, task of research and writing. The study benefitted immensely from Davis' searching criticism of the contents and his calling to my attention certain details which I had overlooked. Important assistance in searching out materials by Miss Hargrave (Librarian), Sara M. Bense and Robert Handley (Mail and Records Branch), Hazel G. Swanson and Emily S. Rankin (Records Management Branch), Alice E. Leonard (Environmental Resources Branch), Frederick A. Lessing (Graphic Arts) and many others deserve special gratitude.

My typists, Suzanne Corona and Arnita Welch (Public Affairs Office) and Jeanette Burge (Loyola University), provided the necessary skill to translate an abominable handwritten script into a readable one.

Special thanks are accorded to my colleagues, John A. Donohue, S. J., Terrance L. Mahan, S. J., and Frank Sullivan (Loyola University of Los Angeles), for reading the manuscript either in part or in whole and making critical suggestions.

My wife, Charlotte, with sympathetic understanding of her husband's profession, has been a steady source of encouragement.

The many who contributed material or drew on their memories to make this historical study as complete as possible will find many evidences of my indebtedness in the pages of this work. However, whatever weaknesses are revealed in this work are solely the fault of the author.

Anthony F. Turhollow
Los Angeles
July 1974

CONTENTS

CHAPTER I

INTRODUCTION

WHY THE LOS ANGELES DISTRICT

On December 31, 1898, New Year's Eve, Captain James J. Meyler established his headquarters as the first District Engineer in Los Angeles for the Corps of Engineers, United States Army. He and his original staff of 18 operated out of one room of the old Central Building in downtown Los Angeles. The census of 1900 recorded 102,479 inhabitants in the City of Los Angeles and another 70,000 in Los Angeles County. With its population only 11,183 in 1880 Los Angeles had mushroomed, to abandon forever its sleepy pastoral existence. Selection as a terminus of a transcontinental railroad had destroyed the comatose existence of Los Angeles.

Long before this time the enterprising inhabitants pushed for a deepwater harbor. Their efforts produced the desired harbor, but not without an arduous struggle which deeply involved the Corps of Engineers. The arrival of Captain Meyler signified that the project for a deepwater harbor for the City of Los Angeles was a reality. In line with the decentralized procedures of the Corps of Engineers and in recognition of the importance of the harbor project the Los Angeles District came into existence to participate in the far-flung operations of an institution with an illustrious history.

In fact the Army Engineer played as vital a role in the development of the West as he had in the East. In the latter area the Army Engineers surveyed the routes for the early railroads and not only supervised the construction of the first railroad in the United States, the Baltimore and Ohio in 1827, but for many years they also furnished private business with technological know-how.

The Army, particularly the Corps of Topographical Engineers, through its explorations and surveys, performed a necessary function in opening up the trans-Mississippi region. As a result of the Mexican War the area included within the boundaries of the Los Angeles District was added to the United States. With foresight the Army did more than accomplish its primary mission, military conquest: it also gathered reliable information about the territory traversed. Prior to the Mexican War, Captain John C. Fremont in his three expeditions to the Southwest set the pattern for collection of geographic, scientific, and economic information on the Southwest.

During the Mexican War, First Lieutenant William H. Emory, on assignment as Chief Engineer Officer to General Stephen W. Kearney,

who assisted in conquering New Mexico and California, collected information on everything of a military, scientific, geographic, and economic nature between Bent's Fort, Colorado, and the Pacific Ocean. But most significant was the mapping work of Lieutenant Emory and his fellow topographical engineers. This work publicized the new western lands and indicated their potential for settlement and development.

Lieutenant Emory, now a brevet major, and other topographical engineers also surveyed the new boundary between the United States and Mexico, probably the first major public works project of the Army Engineers within what became the Los Angeles District. His report on the area of the Gadsden Purchase included the observation "beyond all question, that a practical and, indeed, a highly advantageous route" for a railroad existed through the new territory; an opinion that the Southern Pacific turned into a reality.

After this war the engineers concentrated on the location of suitable routes of communication across the Southwest, harbor surveying, and wagon road building as well as purely military activities. As in the past and in the future there was a similarity between civilian and military usages of engineering projects.

Beginning in 1853 Congress authorized surveying to locate feasible railroad routes from the trans-Mississippi region to the Pacific territories. Ironically, Jefferson Davis was the Secretary of War who sent out survey parties under Army Engineers along the 32d, 35th, and 38th parallels of latitude while the one along the 48th was surveyed by Isaac Ingalls Stevens, Governor of the Washington Territory, but formerly a member of the Corps. Their reports resulted in the construction of transcontinental railroads along the routes selected by the engineers. Thus the Denver and Rio Grande Railroad follows the route proposed by Captain John W. Gunnison near the 38th parallel; the Santa Fe Railroad that of Lieutenant Amiel W. Whipple along the 35th parallel; and the Southern Pacific that of the surveys along the 32d parallel; while the Northern Pacific tracked over the route of Governor Stevens along the 48th parallel.

These engineers not only surveyed and mapped the best routes along the rivers, through the plains and over the mountain passes, but also produced reports which recorded for the first time information on meteorology, geology, mineralogy, zoology, botany, Indian cultures, and numerous other facets of this area. They stimulated the settlement and development of this new West.

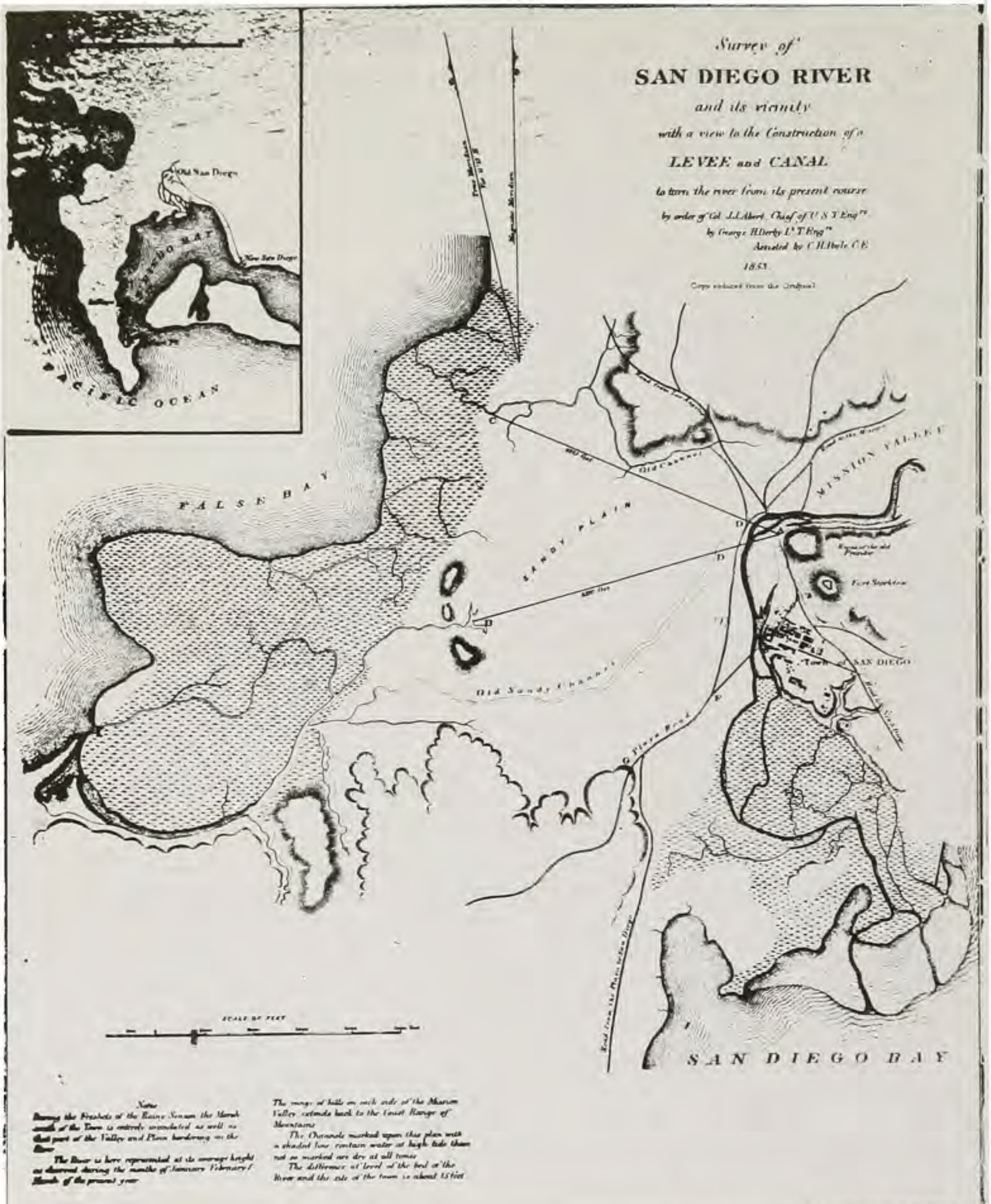
Before the Civil War other important explorations by Army Engineers took place within the boundaries of the Los Angeles District. Second Lieutenant George Horatio Derby, a legendary contributor to

Californiana, in addition to his wagon road reconnaissances, made a significant exploration of the lower Colorado River, seeking a badly needed supply route to Fort Yuma at the confluence of the Gila and Colorado Rivers. On November 1, 1850, Lieutenant Derby sailed aboard the *Invincible* via the Pacific Ocean and the Gulf of California to test the navigability of the relatively unknown Colorado River to Fort Yuma. Lieutenant Derby concluded that the lower Colorado "may be navigated at any season of the year by a steamboat of 18 or 20 feet beam drawing 2-1/2 to 3 feet of water."

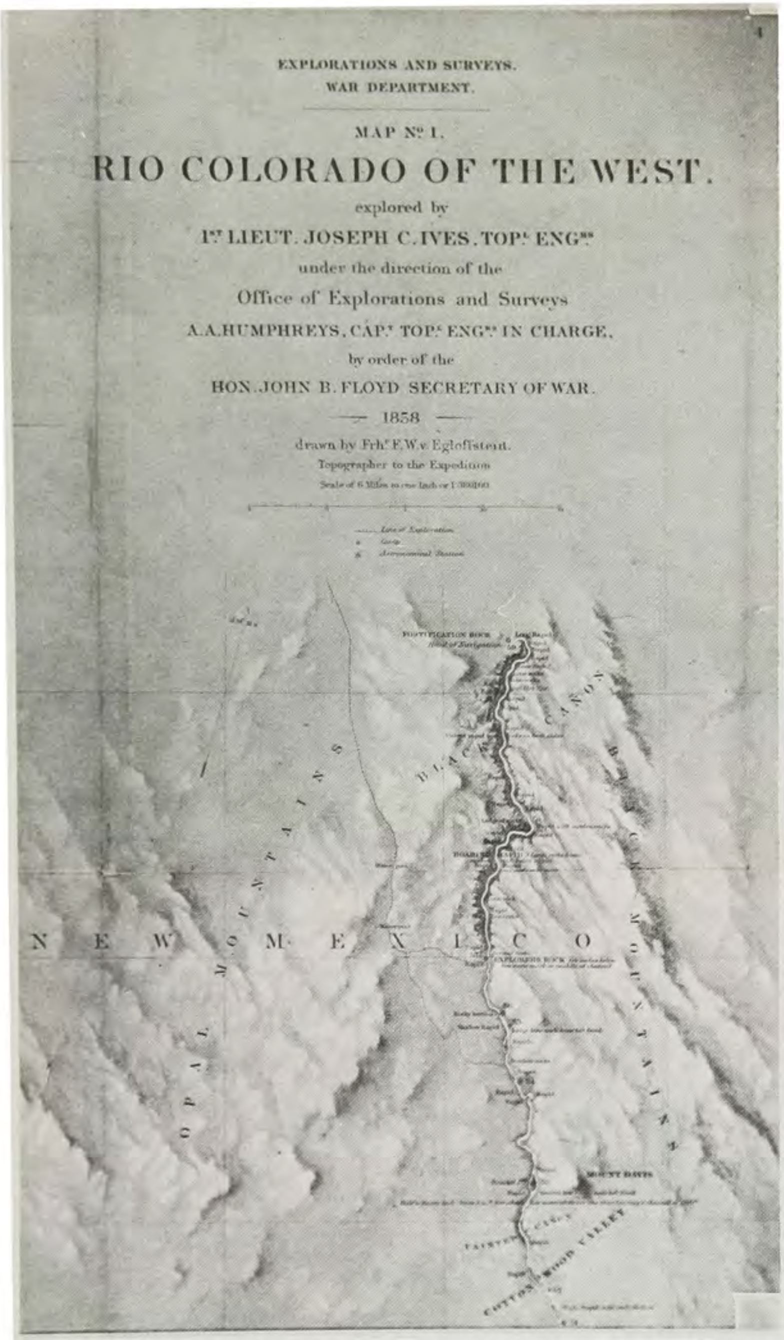
In 1853 Lieutenant Derby began work on the first civil works project in the District. In 1854 he completed the project for diverting the San Diego River into False Bay to protect the San Diego Harbor from filling up with silt from the river. In keeping with his character he constructed the dam not across the river but parallel to it, but it worked until washed away by floods.

Following Derby's recommendations other officers completed the task of determining the navigability of the Colorado River. Among the more interesting assignments was the one granted to Lieutenant Joseph C. Ives. His exploration purposedly covered the period from the end of November 1857 through May 1858 during the worst and lowest stage of the Colorado. His steamer, the *Explorer,* built in Philadelphia and transported in sections via ocean shipping to the mouth of the Colorado, and reassembled there, steamed up the Colorado reaching Black Canyon (Vegas Wash below Hoover Dam) which Lieutenant Ives concluded to be the head of navigation. Upon the completion of this assignment Lieutenant Ives with a small group of men struck out overland through the Black Mountains and the Cerbat Range, and reached the south rim of the Grand Canyon before concluding his explorations at Fort Defiance, Arizona, fortunately just before the Navajos went on the warpath. Lieutenant Ives and his colleagues had determined the extent of navigability of the Colorado, traced a path to the Mormon Road within the Great Basin, and became the first white men since the Spaniards to tread the floor of the Grand Canyon. Lieutenant Ives also produced a dramatic account of these experiences and the acquired knowledge.

In 1859 Captain John N. Macomb explored the tributaries of the Colorado and the entire canyon area. In particular he traced the whole drainage of the San Juan River and indicated the function of the Grand and Green Rivers. The final explorations prior to the Civil War took place in the Great Basin and Wasatch Mountain region under the command of Captain James H. Simpson. His recommendations produced routes followed by the Pony Express, mail, stage, and freighting companies, and immigrants to California.



Survey for the first civil works project in the Los Angeles District by Lt. George H. Derby.



Portion of Map No. 1 of the expedition by Lt. Joseph C. Ives to determine the navigability of the Colorado River shows the head of navigation. (Lt. Joseph C. Ives, *Report Upon the Colorado River of the West.* Washington, 1861.)

The Explorer, steamer used by the Ives Expedition, in the mouth of the Black Canyon, near the present day site of Boulder Dam. (Ives, *Report*)

During the Civil War the Corps of Topographical Engineers merged back into the Corps of Engineers. Further explorations and surveys of the Colorado River Basin occurred from 1869 to 1879, but primarily by civilians with authorization from the Federal government. The one exception was Lieutenant George Wheeler, who, as the last representative of the Corps in the mission of exploring and surveying this area, traveled like Lieutenant Ives up the Colorado and produced a volume of documentation which shed considerable knowledge on the Colorado Basin.

With Wheeler's *Report* the initial phase of mapping and measuring the region from the bend of the Missouri to the Pacific Coast and from Canada to Mexico and the compilation of scientific data was completed, and these particular missions of the Army Engineers ended in the West. The Army Engineers continued their work, now back to serving as the instrument for the construction of public works which would make the area livable for man. The feats of the early engineers are commemorated by their names being given to prominent geographical features.

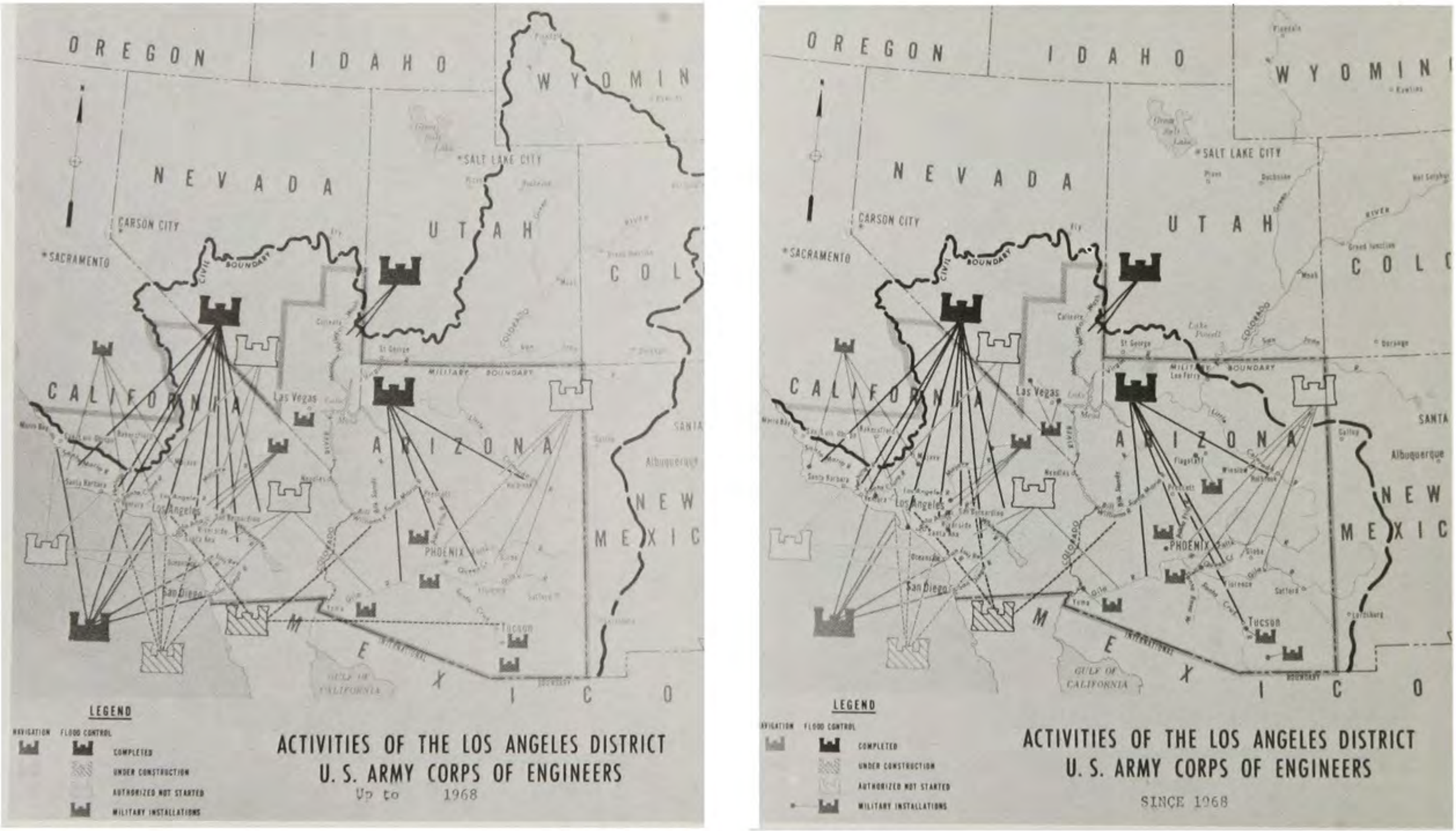
After Wheeler, several surveys of the Colorado were undertaken to determine whether work to improve navigation of the river was justifiable. Some work for the removal of dangerous sandbars and the construction of diversion channels to improve navigation took place prior to 1900. By and large, negative recommendations resulted from authorized survey reports as in those of Major W. H. H. Benyaurd in 1888 and 1890, and Captain Meyler. After 1900 the District concentrated on the enforcement of laws enacted by Congress for the protection and preservation of the navigable waters of the United States, in this District the Colorado River.

Prior to the momentous decision to construct a man-made harbor at San Pedro, Army Engineers assisted in determining what harbor improvements were feasible and necessary. Their realistic reports enabled the authorities in Washington, D.C., to curb somewhat the grandiose harbor plans of many communities occupying indentations of the Pacific Coast.

Thus, investigative and exploratory works by engineers operating out of San Francisco led to major harbor improvements at San Diego, Wilmington, and Port San Luis Obispo but none for harbors like Newport, San Buenaventura, San Simeon or Redondo Beach.

Among those engaged in these activities was Captain Meyler. For example, in June 1891 he submitted a report on operations at Wilmington Harbor, which indicates that he had at least 10 years of engineering experience in the area before his assignment as District Engineer, resident in Los Angeles. Prior to 1908 the District had varying titles. Up to 1898 all projects received supervision from the headquarters in San Francisco, but after a district headquarters was established at Los Angeles, annual reports were entitled "Improvement of Rivers and Harbors in California South of San Francisco." Finally in 1908 the reports were entitled "Report Upon the Improvement of Rivers and Harbors in the Los Angeles, California, District."

Up to April 30, 1942, the Los Angeles District included those drainage basins tributary to the Pacific Ocean that are in California between Cape San Martin (about 275 miles north of the entrance to Los Angeles Harbor) and Mexico; that part of the Great Basin, intensely explored and surveyed by the Army engineers of the 19th century, that is in Utah, Idaho, Wyoming, southeastern Nevada and California; the entire Colorado River drainage basin which is in southeastern California, southeastern Nevada, southern and eastern Utah, southwestern Wyoming, western Colorado, western New Mexico and all of Arizona; and the American portions of those small drainage basins in southern Arizona and southwestern New Mexico west of the Continental Divide that drain southward into Mexico.



Two Maps of Boundaries of LAD.

During World War II reorganization of the Corps of Engineers resulted in the transfer of the Great Salt Lake Basin and the Colorado River Basin upstream from the mouth of the San Juan River to the jurisdiction of what was then the Salt Lake City District of the Mountain Division. Now these areas are under the jurisdiction of the Sacramento District. Even after this loss the Los Angeles District still comprised approximately 345,000 square miles, the largest district in the continental United States. To coordinate military construction activities of the District with the functions of the Ninth Service Command, the eastern boundary of the District was shifted to the Arizona-New Mexico border to coincide with the eastern limit of the Ninth Service Command. For flood control projects the Continental Divide served as the eastern boundary of LAD.

In the years before 1935 the Los Angeles District primarily engaged in the development of harbors along the coast, military construction, and a certain amount of investigative and exploratory work. The major achievement of LAD was the creation of the largest man-made harbor in the world, Los Angeles, out of swamp and overflow land crossed by various meandering sloughs around Wilmington and San Pedro. Another harbor, Long Beach, also appeared as a twin to the Los Angeles Harbor. Actually the first improvement of these harbors commenced with the authorization of March 3, 1871, for development of the inner harbor at Wilmington. After a prolonged battle which deeply involved the Army Engineers the first authorization for the outer harbor at Los Angeles occurred in the Rivers and Harbors Act of June 8, 1896. Work on the breakwater began on August 12, 1898. This action also led to the establishment of district headquarters at Los Angeles. In 1906 local interests began development of the Long Beach Harbor. In 1930 Congress authorized the District to assist in the development of the Long Beach Harbor. From that time the District under direction of Congress has continued in the never-ending task of fitting major harbors to meet the challenge of changing demands on the ports.

Prior to 1935, construction of breakwaters and dredging also occurred at Newport, San Diego and San Luis Obispo Harbors. Military construction was limited to fortification work at Fort MacArthur and Fort Rosecrans. The work force consisted of 12 to 20 employees with an annual expenditure ranging from $500,000 to $2,000,000. Key district engineers were Captain Meyler, Captain Amos A. Fries, and Lieutenant Charles T. Leeds, while key civilian personnel included David E. Hughes and Harry W. McOuat. All of these individuals made major contributions to harbor development in the District.

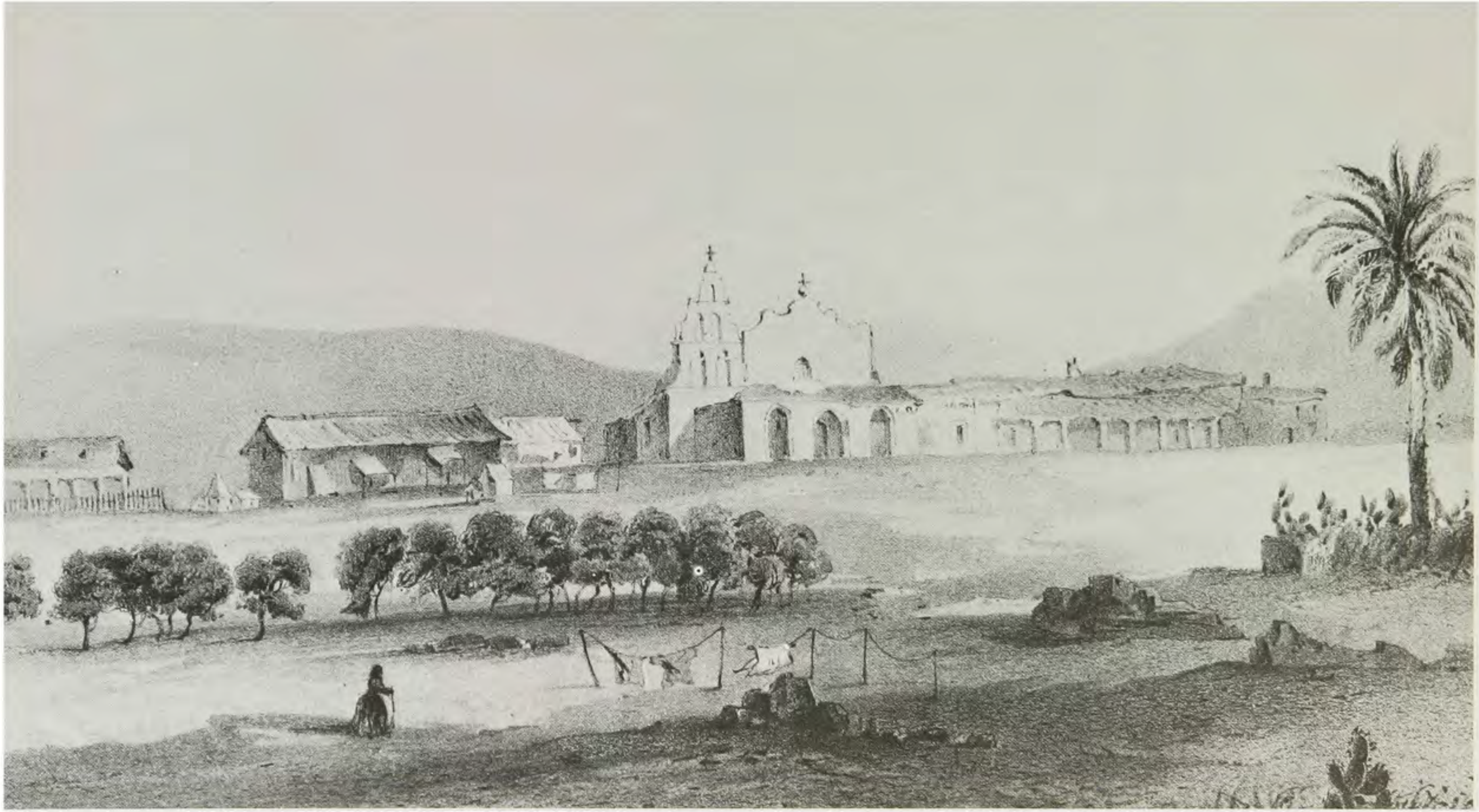
In 1935 a virtual revolution struck the Army Corps of Engineers and the Los Angeles District as the President mobilized the nation to cope

with a peacetime national emergency – the economic depression of the 1930's. To provide jobs, the New Deal established the Federal Emergency Relief Administration, the Works Progress Administration, and other agencies. Among badly needed public works of considerable value to the country were flood control projects.

Severe floods subjected areas within the District to heavy property damage and loss of lives. Local attention to the problem of flood control in Los Angeles was activated in 1914 when floods produced a public outcry for the formulation of a definite flood control policy for Los Angeles County. Plagued by flood disasters, local interests forced the State legislature to pass an Enabling Act which created the Los Angeles County Flood Control District in 1915. Under the direction of a competent staff, work began on developing flood control plans. Rapid urbanization of the metropolitan region of Los Angeles during the 1920's greatly increased storm water runoff. By 1930 many officials recognized that the construction program of Los Angeles County failed to keep pace with the increased runoff. LAFCD now initiated the planning of a comprehensive program of flood control. The disaster on New Year's Day 1934 indicated the need for Federal assistance to speed up the flood control program. To accelerate the program, funds were made available by both the WPA and the FERA with the stipulation that the work be done under the direction of the Army Corps of Engineers.

The Federal Flood Control Act of 1936 definitely assigned flood control for the entire country to the Army Corps of Engineers. In preparation Major Theodore Wyman, Jr., in 1935 began reorganization of the Los Angeles District to cope with its added responsibility. A tremendous expansion of personnel resulted as Major Wyman drafted men from other districts, with the bulk of the transfers coming from the Kansas City, Omaha, Fort Peck, and Vicksburg Districts. The remainder of the increase was located in local employment sources. Approximately 900 civil service employees were required to design and construct the flood control projects. Until 1938 hired labor, consisting of several thousands from the ranks of the unemployed, performed construction under direct supervision of the new staff in the District. Thereafter construction by contract became the established procedure. Among the personnel added in the 1930's were individuals who became the strength of the District through the 1960's, including William J. Leen, Harry W. Thompson, Guy B. Bebout, D. W. Morrison, O. A. Ochsner, Frederic C. Bennett, O. N. Rugen, Lee R. Henning, James G. Jobes, Ken Willoughby, F. Meinecke, George F. Arndt, Gordon Lilley, Clyde A. Hollcraft and others.

Under the direction of Major Wyman and Lieutenant Colonel Edwin C. Kelton, comprehensive plans for the Los Angeles County



Mission San Diego, c. 1853.

San Diego Harbor, 1961.

Drainage Area were submitted to higher authority and authorized by Congress. In other areas within the District, flood control districts also were established in Santa Barbara, Ventura, San Bernardino, Riverside, Orange and San Diego Counties. In coordination with these local agencies the Federal flood control program was carried out by LAD. In later years investigations and construction for flood control were executed in all areas within the District.

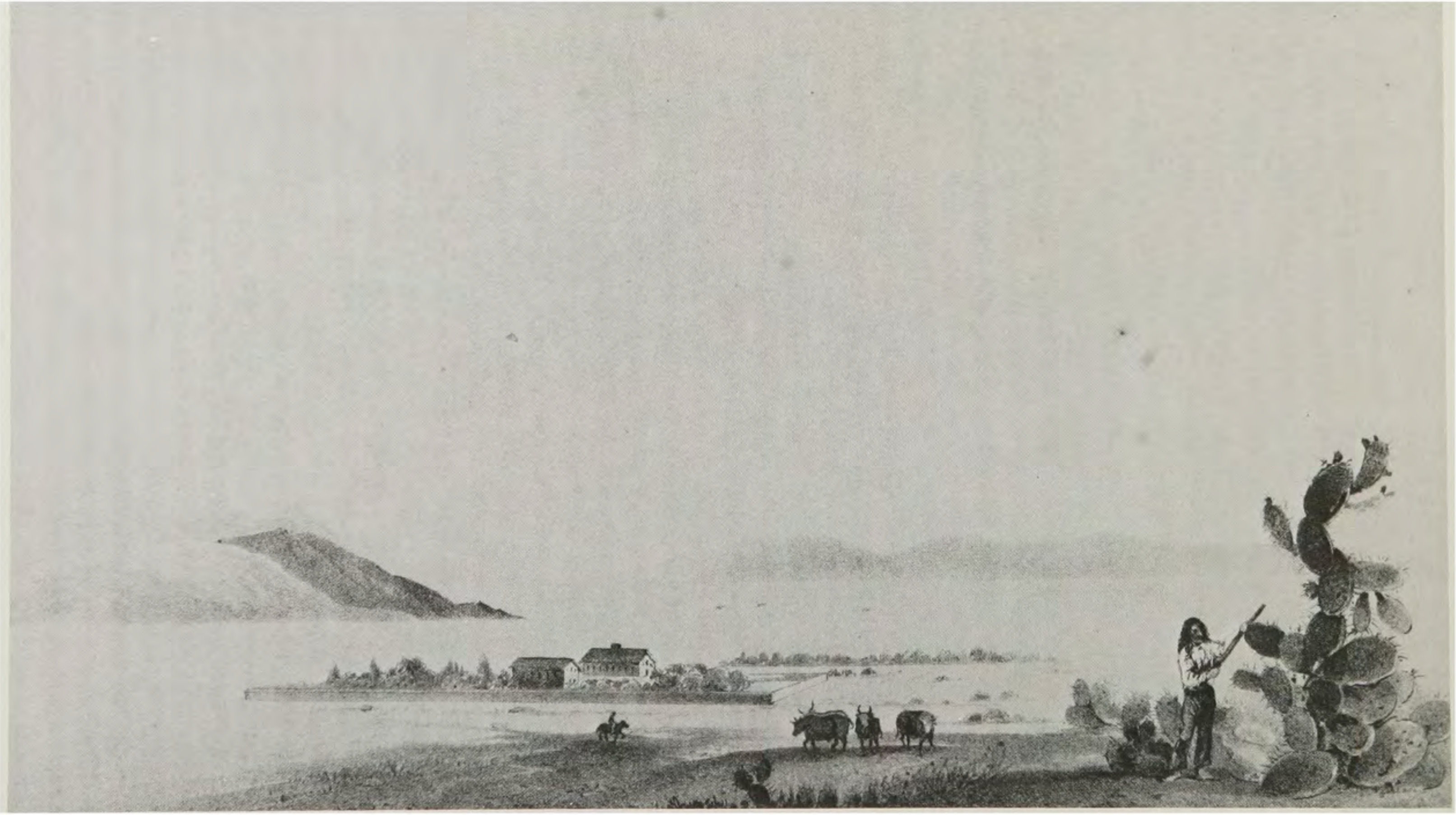
Flood control investigations by the Los Angeles District led to the abandonment of a single-purpose approach for flood control, to multipurpose considerations, including irrigation, municipal and industrial water supplies, pollution abatement, low-flow regulation, water quality, hydroelectric power, recreation, navigation, fish and wildlife, and other uses.

In addition, to attain efficient development and conservation of the resources of the nation, Congress required the formulation of comprehensive and unified plans for economically integrated river basins like the lower Colorado River, which also demanded cooperation between all interested local, State, and Federal agencies.

Even after a project was completed District Engineers made changes, as in the case of the Whittier Narrows Reservoir, originally a single-purpose flood control project.

Since Americans, like other human beings, continue to encroach on flood plains, flood damages increase in spite of the success of completed flood control works. To assist local authorities in decision-making with respect to proper use of flood plains, Congress authorized the Corps of Engineers through Section 206 of the 1960 Flood Control Act to prepare flood-plain information studies when requested by local officials. Thus at about the time that the Los Angeles District was completing the flood control system for the metropolitan region of Los Angeles its efforts were directed to reduce the need for flood control projects, particularly when elements of the American society were raising environmental objections in regard to flood control projects.

Early in the 1930's Congress placed upon the Army Corps of Engineers responsibility for control of beach erosion along the coastline of the nation. For the Los Angeles District this meant that increasing attention was directed to initiating and developing programs to preserve the environmental integrity of the scenic and valuable coastline of southern California. To meet the recreational requirements of the burgeoning population in southern California, LAD gave prime attention to the preservation and expansion of beaches. To devise effective means of controlling coastal erosion, LAD launched a number of scientific investigations and studies in cooperation with local and State agencies.



San Fernando, c. 1853.

San Fernando Valley (1971).

In recognition of the importance of recreation as Americans obtained more leisure time, Congress instructed the Army Corps of Engineers to add recreational facilities within existing and future projects. In addition to carrying out these instructions to provide public and private recreational facilities, such as public parks, athletic fields, golf courses, or wildlife refuges around flood control structures, LAD also moved into the development of small boat harbors. By 1940 investigative studies conducted during the regimes of Major Wyman and Lieutenant Colonel Kelton provided a basis for determination of recreational navigation within the District. Major results from these recommendations occurred in the post World War II period.

As the Los Angeles District was in full swing with these civil works, the District once again underwent a dramatic shift in its activities, beginning in 1939. As Congress and the President had called upon the Corps of Engineers to assist in the economic rehabilitation of the American nation, now the emphasis was placed on military defense against the international aggressors of the time.

In contrast to previous wars in which the United States engaged, this time the Los Angeles District probably had a more significant role than any other engineer district in meeting the military obligations of an international crisis which threatened to destroy the American way of life. Under Lieutenant Colonel Kelton and Colonel Rufus W. Putnam, a complete reorientation of the District to military construction ensued. Many civilian members of the staff exchanged civilian clothes for military uniforms. Some remained with the District while others departed for far-flung theaters of war – but all with the same purpose of devoting their engineering know-how to the solution of the new problems of military construction. The unique policy of having in being an established organization of officers and civilians engaged in acquiring engineering experience, knowledge, and skills paid off, particularly since in World War II the success of the Armed Forces depended on the ability of the engineering organizations to meet the technical challenge of modern war.

By 1941 all military construction was placed under the supervision of the Corps of Engineers, which was no reflection on other agencies of the government but was necessitated by the urgency of the immense construction program thrust on the nation.

Within LAD a tremendous increase in personnel transpired as the volume of actual military construction rose to a rate of approximately $20,000,000 each month beginning in December 1941. The details of this harried and nearly forgotten war construction program will be stressed in this historical study to demonstrate how the District met the challenge of the times.

Ever conscious of its dual civil and military responsibilities, LAD prepared an impressive backlog of civil works for the postwar period. Actually this planning called for an orderly continuation of projects, upon many of which work was suspended for the duration of the war as a result of requirements of manpower and critical materials for wartime construction.

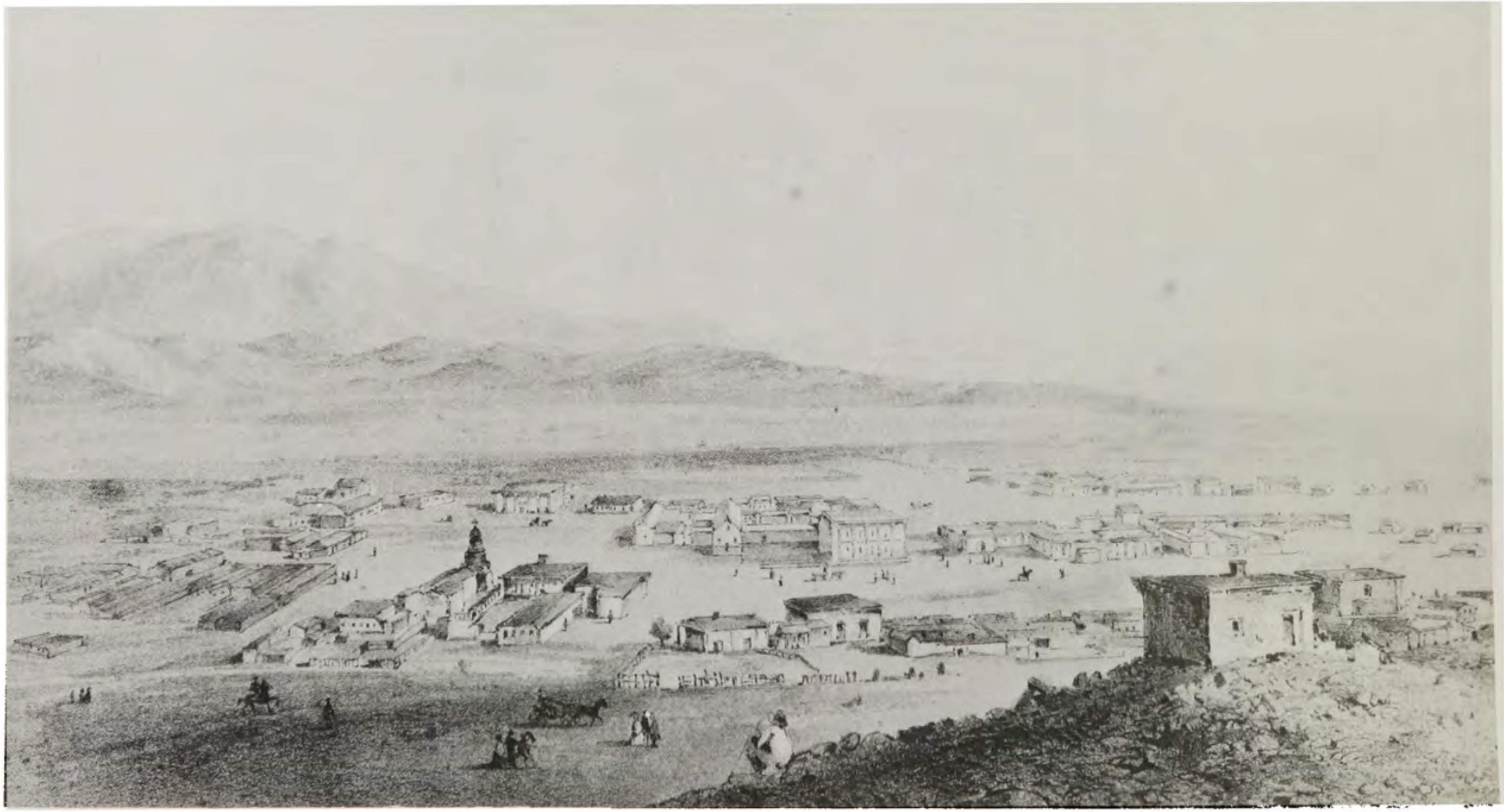
The military victory ending World War II did not result in the diminution of activities for the Los Angeles District. Many district employees placed their uniforms in mothballs, returned to apply their war experience to civil works, and regaled each other with accounts of their military exploits. As Congress poured out funds, the District pushed to completion authorized projects, prepared studies of proposed works, and established an enviable record of civil works accomplishment. The District concentrated on the maximum development of scarce water resources in the semi-arid area encompassed by its boundaries. The phenomenal growth in population and economic development of southern California, Arizona, and the Las Vegas region of Nevada required the fullest practical use of virtually all water resources within this area.

In contrast to other postwar periods little or no decline in military construction ensued, except for a few years between the end of World War II and the outbreak of the Korean emergency in June 1950. During that war the District and the rest of the Corps of Engineers formed an active and indispensable element in maintaining the fighting potential of the Armed Forces so that even though outnumbered they held at bay enemy forces.

This event and others of the Cold War forced a reluctant American populace to appropriate funds for establishing a worldwide chain of military defenses for deterring aggression. Within the bounds of LAD, the District built the bases and facilities for conventional air and land power and for the development and deployment of missiles, ranging from antiaircraft to intercontinental ones.

Thus this historical survey will study in depth the myriad activities of the Los Angeles District – major harbors, small harbors, flood control, water resources, beach erosion, recreation and military construction – from its beginnings, but also earlier if significant to the narrative, to approximately 1965.

The broad objective of this historical project is to assess the role of the Los Angeles District in assisting Congress to meet the requirements of the people in this dynamic region for the efficient development, utilization, and preservation of limited resources so necessary for the advancement of the regional economy and the welfare of the people.



Los Angeles, c. 1853. (*Reports*, p. 35)

Los Angeles (1965).

CHAPTER II

LOS ANGELES DISTRICT AND MAJOR HARBOR DEVELOPMENT

Los Angeles and Long Beach Harbors illustrate dramatically how cooperation of private enterprise, local government, and Federal Government converted a hostile environment to the service of people. In this process harbors were developed which lifted a sleepy pastoral environment into a dynamic metropolitan region with the greatest concentration of population, industry, agriculture and communications on the Pacific Coast. Through bold initiative and creative vision the Army Engineers of the Los Angeles District not only transformed the open roadstead at San Pedro into magnificient harbors but also advanced the frontiers of civil engineering.

An example of those who doubted the feasibility of living in the area, let alone constructing a harbor, was Richard Henry Dana, who in 1834 in *Two Years Before the Mast* described the bay at San Pedro as "the hell of California." He could not conceive of what would bring anyone to a place which he left with no feeling of regret. Upon his return 25 years later he still had not changed his mind, but others, among them Army Engineers, with prophetic vision foresaw the evolution of a large modern harbor. To them, instead of a roadstead exposed to every wind and wave action except from the northwest, there actually was a potential harbor area protected by Point Fermin from westerly winds and waves and partially from southern wave action by Catalina Island, about 25 miles away. In addition, the bottom held anchors very well. Another vital factor in the major development of the seaport was the presence inland of a land-locked lagoon.

In spite of the uninviting character of the bay for harbor usage, irregular service as a port for loading and unloading vessels began with the founding of the mission at San Gabriel in 1771, and the pueblo of Los Angeles in 1781, as part of the expansion program of Spain. Spain, as did all the major colonial powers, attempted to exclude trading activities between foreigners and Spanish colonials. Nevertheless, as a sea-faring people with active trading interests with Asia, the Americans early displayed an interest in the harbors of California as necessary way stations for their Far Eastern Trade.

In 1805 the American ship the *Lelia Byrd*, under Captain Shaler, enroute back to Boston from the Hawaiian Islands, unable to obtain provisions at Avalon on Catalina Island, pulled into San Pedro, where necessary provisions were exchanged readily for New England manufactured goods. Soon a lively contraband trade emerged in which

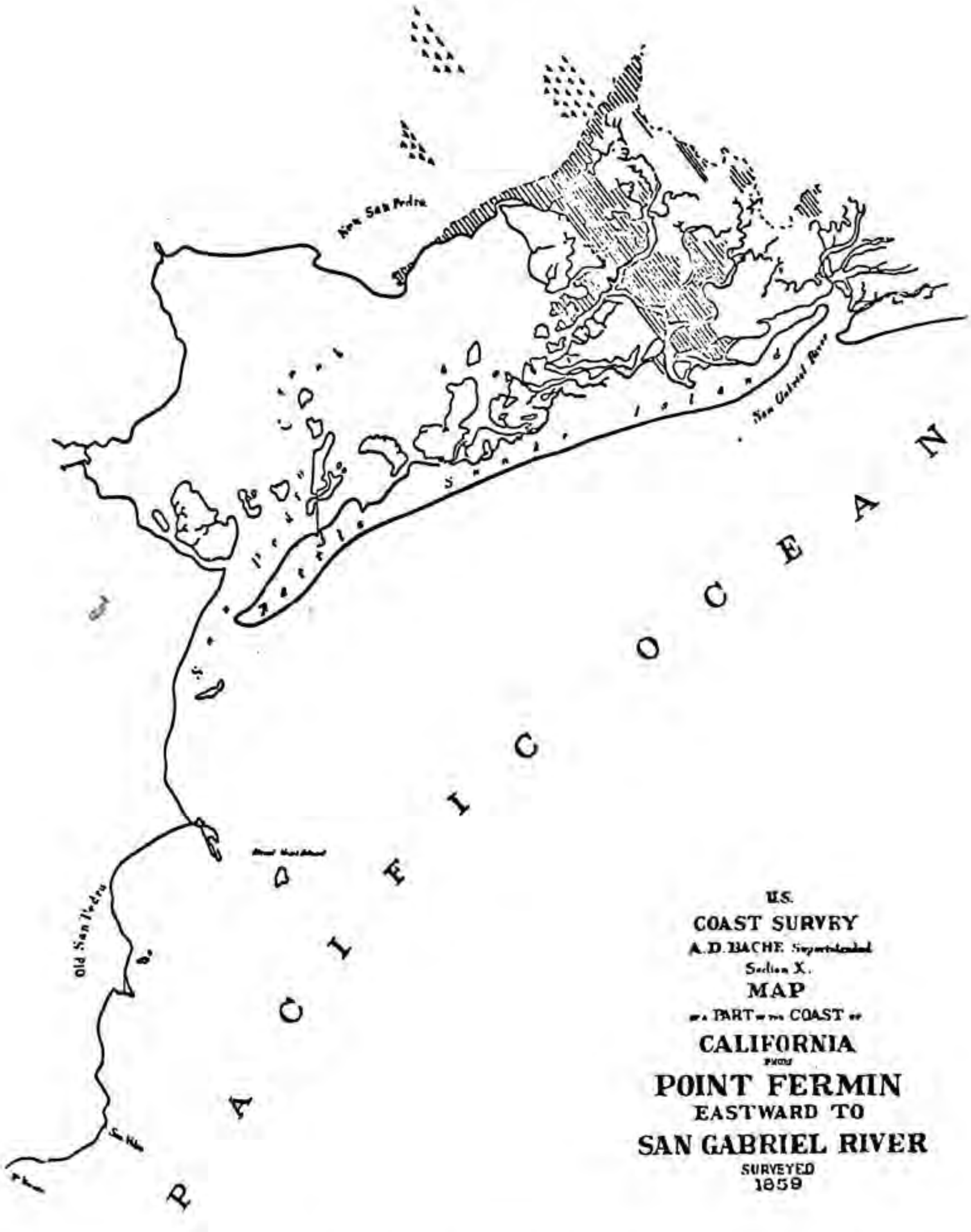
at first sea otter skins, and then cowhides and tallow, were bartered for various items, including cloth, sugar, and household articles. Thus smuggling provided the first real interest of Los Angeles in the harbor at San Pedro.

When Mexico achieved its independence from Spain the new government declared all ports open, but heavy duties were established. In 1826 San Pedro became a port of entry, with the collector of revenue stationed in Los Angeles, 22 miles away. In July 1828, the port was closed to foreign vessels and legal trading shifted to Catalina Island. In practice, smuggling continued as a way of life for Californians and Americans.

The headquarters for foreign vessels shifted back to San Pedro in 1846 as the result of the confirmation of a Mexican land grant, known as the Palos Verde Rancho, originally awarded in 1827. This rancho fronted on the shore of San Pedro Bay, but with foresight 42 acres of land with 1,400 feet of water frontage where the lower reservation of Fort MacArthur is currently located was reserved for public use, an ancient Spanish custom. Simultaneously war between the United States and Mexico erupted. By the Treaty of Guadalupe Hidalgo the United States acquired California which was admitted into the Union in 1850.

With gold as the attraction, northern California boomed, while southern California peacefully slumbered on in its pastoral economy. However, a number of future civic leaders who played an early role in the development of the harbor at San Pedro Bay arrived in Los Angeles County from various parts of the United States. Among them were "Admiral" Phineas Banning (who established a transportation business hauling freight and passengers from San Pedro Bay and Los Angeles to points throughout the southwestern region of the United States); John G. Downey, Governor of California in 1860 and future financier; William Sanford, an early postmaster for Los Angeles; and Benjamin D. Wilson, a leader of the Californians in their struggles with the Mexican governors of California.

Displaying the perspicacity which became characteristic of many leaders in southern California, these men combined their resources to purchase 2,425 acres of land from the Rancho San Pedro, which was owned by the Dominguez family, at a total cost of approximately \$20,000. Four years later they obtained another 1,000 acres. At the head of a slough about 4 miles northeast of San Pedro, Banning established a town, which he ultimately named Wilmington after his birthplace in Delaware, and built a timber wharf. There were shallow shifting entrances to this inner harbor on both sides of Deadman's Island. Albeit these channels were very crooked and unreliable, Banning



and others discovered it was profitable to take lighters through them to ocean-going vessels anchored in the open San Pedro Bay.

A fortunate occurrence for the future of harbor development took place in December 1857, when the outside boundaries of Rancho San Pedro were surveyed, "excepting, reserving and excluding from said tract, as thus surveyed, that portion thereof covered by the navigable waters of the inner bay of San Pedro . . . ."

HARBOR LINES OF 1938 SUPERIMPOSED ON MAP SHOWING CONDITIONS IN 1859

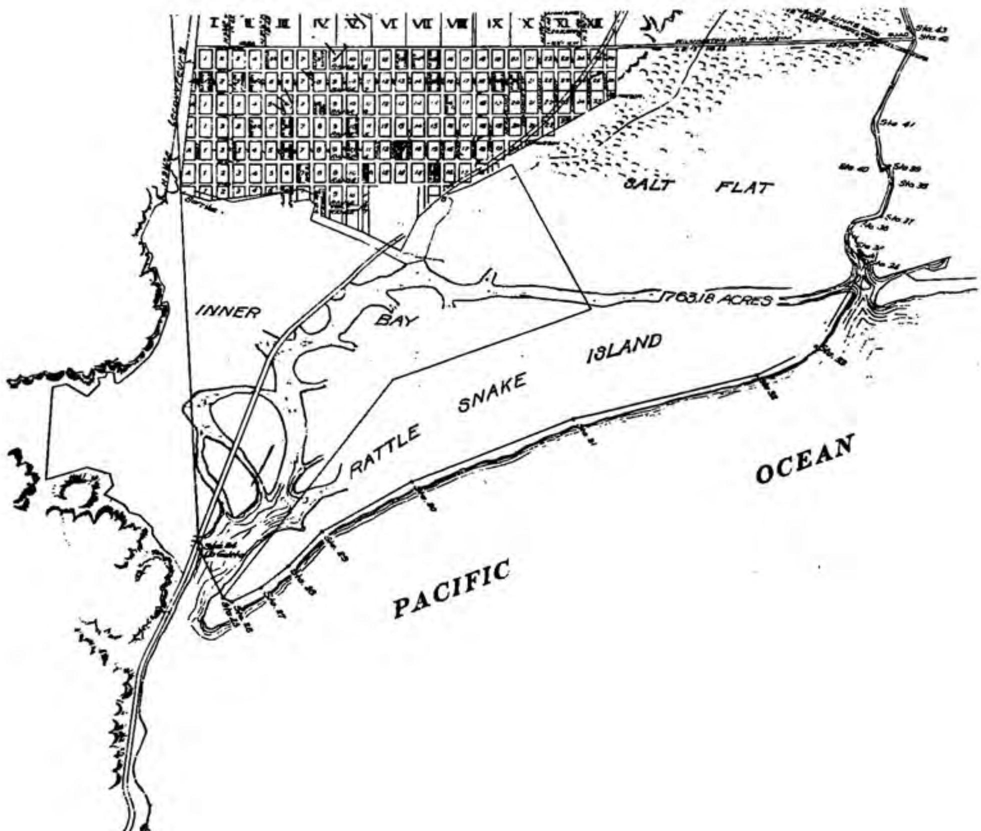
Ultimately this language would introduce the concept of a publicly controlled seaport of large proportions. Before that could happen many prolonged and bitter struggles occurred, first where to place the harbor and then whether to have it publicly controlled.

To facilitate the movement of freight and stimulate commerce, agitation for the construction of a railroad between Los Angeles and San Pedro was initiated by newspapers in 1861. Public officials, local and State, and civic leaders persuaded the citizens of the City and County of Los Angeles to authorize the issuance of bonds costing $225,000 to finance a railroad between the City of Los Angeles and Wilmington. In 1869 the Los Angeles and San Pedro Railroad went into operation, also an additional stimulus for a deepwater harbor at San Pedro.

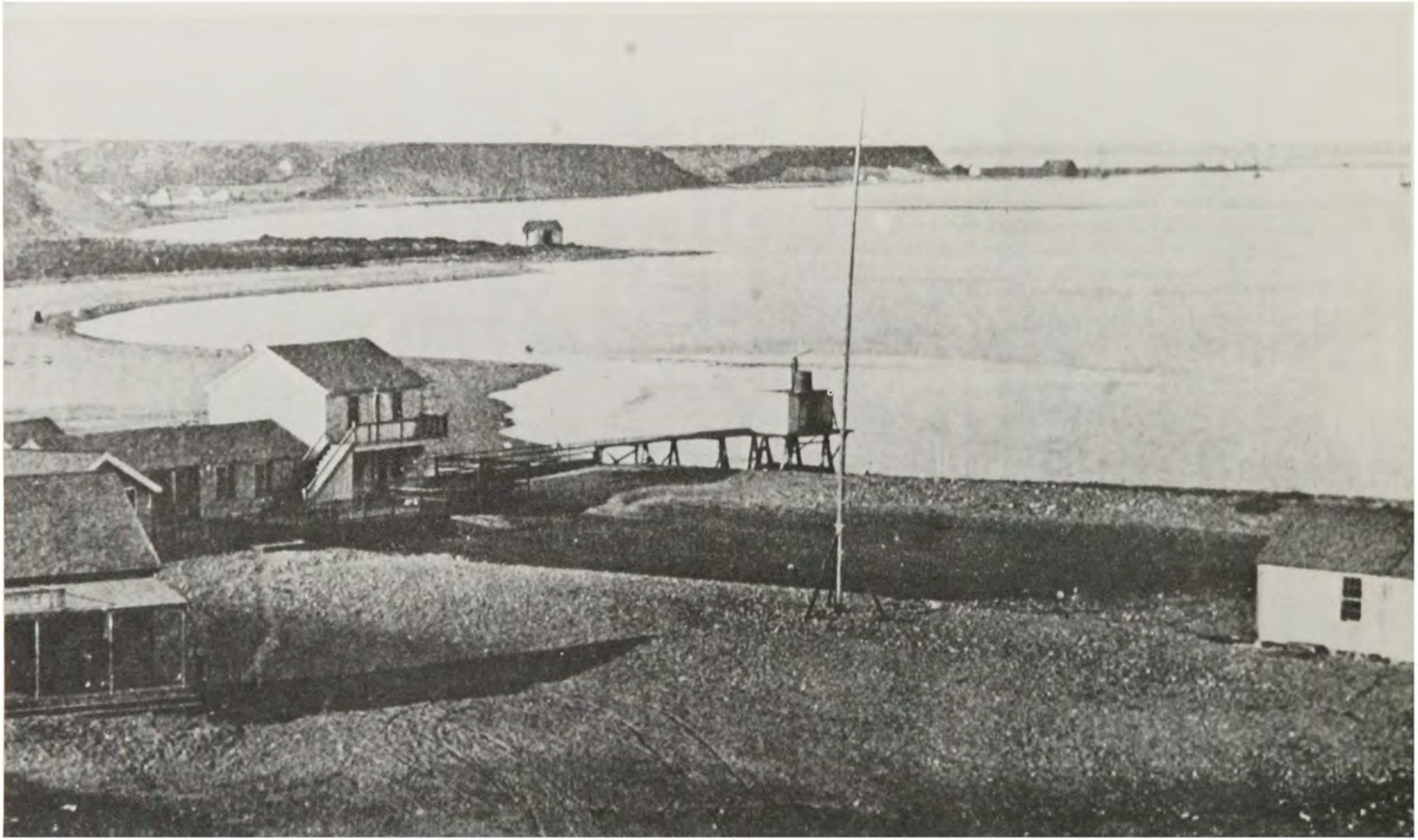
Since the financial resources of Los Angeles and the State of California were insufficient to provide an improved harbor, the people turned to their government in Washington. Don Benito Wilson and Phineas Banning requested Brigadier General Barton S. Alexander, President, Board of Engineers, Pacific Coast, to comment on the inner harbor. General Alexander assisted local interests by presenting an unofficial report favoring improvement of the estuary at Wilmington. In 1868 Congress reacted favorably to the importuning of the Angelenos by authorizing the Corps of Engineers to survey the harbor at Wilmington with respect to the needs of commerce and whatever improvements might be deemed necessary. With that survey began "an enduring, productive partnership of private enterprise, local governments, and Federal Government" which continues to this date.

San Pedro Bay, c. 1870. (Huntington Library Collection)

Wilmington Harbor, c. 1870.
(Huntington Library Collection)



Wilmington Harbor, c. 1870.



Timms Landing, c. 1876.

San Pedro Harbor entrance from the bluff, showing Timms Landing and Deadman's Island, 1883.

Upon completion of his survey, Major R. S. Williamson, CE, recommended improvement of the harbor at Federal expense. Although he advanced an ingenious plan which would utilize the tidal flows to scour a channel to the desired depth by confining a tidal prism, he was unable to justify the cost of a protective breakwater of expensive granite blocks which was essential to his proposal.

Under continuous pressure from local interests Congress authorized an inadequate appropriation of $200,000 for a breakwater at Wilmington in 1871. To Major G. H. Mendell went the assignment of formulating an acceptable plan.

While accepting the Williamson proposal, he substituted cheaper wood and stone for the expensive granite as basic material for the breakwater. Ten years elapsed before the project was completed. Delays resulted from failure by the first contractor, an unsatisfactory original structural design, and lack of appropriations by Congress.

Finally, in 1881 a breakwater, 6,700 feet long, of three types of construction, costing about $530,000, closed the gap between Rattlesnake and Deadman's Islands.

During the delay local inhabitants vented their frustrations by sarcastically calling the jetty "Banning's Gull Roost." The patience of the engineers did not go unrewarded as their expectations were exceeded. Many years later H. W. McOuat, an outstanding expert on harbors on the staff of LAD, concluded that while the jetty was structurally deficient it did perform its intended function, scouring a dependable channel 250 feet wide and 10 feet in depth. In addition, engineers could rely on tidal scour to maintain the desired depth with little or no dredging.

As soon as the engineers finished the project, local interests, impressed by the increasing commercial use of Wilmington and the increased size of ships, petitioned Congress for further improvements, a request granted by Congress but again with inadequate funding.

Again relying on tidal scour, the Corps of Engineers secured the 15 feet depth desired by extending the original east jetty beyond Deadman's Island to the 3-fathom curve and by constructing a correlating west jetty which jutted out 3,500 feet from Timm's Point in the general direction of Deadman's Island, in order to maximize the tidal flow.

This time dredging was necessary to assist the tidal scour which could not cut the hard shale found in many places at the bar. This 1881 project ran into the same problems as the first project, but finally was completed in 1893.

Local interests also obtained additional authorization to dredge 18 feet across the bar and to widen and straighten the channel inside, but the actual work was delayed by the major controversy over the location of a deep-water harbor. The inner harbor improvements at Wilmington were designed for coastal shipping, but not intended for deepwater vessels.

This fact was noted by Major Mendell in his 1871 report to the Chief of Engineers with the prescient attitude of an experienced engineer that while the Wilmington improvements were necessary, ". . . it is apparent that a breakwater in the bay of San Pedro, which would give security to vessels under its lee at all times, would be a very desirable construction, and it is probable that at some future day, the commerce of this bay may obtain such dimensions as to justify its construction, which could not be made under the expense of several millions of dollars." By 1890 all interested parties shared these views except as to the location of the deepwater harbor. Thus more than a quarter of a century elapsed before Mendell's suggestion became a reality, for bitter struggles of many powerful and resourceful interests first had to be resolved. During that classic struggle the very integrity of the Corps of Engineers was assailed.

Mendell, who retired as a colonel, is a classic example of the many self-effacing Army engineers who, anonymously and unheralded, perform valuable services for the country. For nearly 50 years he ranged up and down the Pacific coast, particularly during the 1870's and 1880's when he had a key role in the development of harbors and fortifications on that coast. His first association with Los Angeles occurred in 1855, and upon retirement he represented the interests of that city on a water arbitration board. In 1891 he served as presiding officer of the special board of engineers which recommended San Pedro Bay as the site for a deepwater harbor.

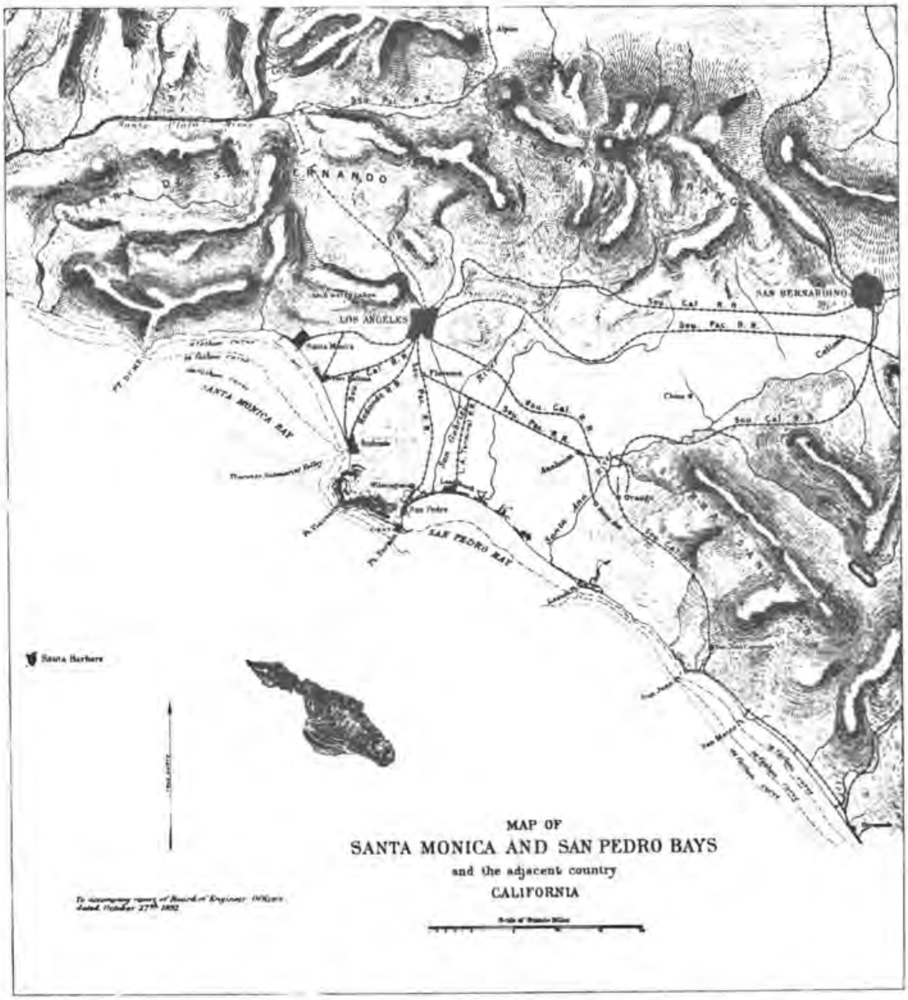
The proposed deepwater harbor became enmeshed in the machinations of powerfully ambitious men, of competing railroad interests, and of aspiring communities in Los Angeles County. Four special boards of engineers, local and Federal officials, civic-minded citizens and groups, and vitally concerned business interests wrestled with the issue. In this contest the Corps of Engineers was on the "side of the angels."

Railroad development was now inseparable from harbor development in southern California. In the identical year, 1869, that the small but vital Los Angeles and San Pedro railroad linked the inner harbor at San Pedro with the City of Los Angeles, a comparatively small place which in the Census of 1870 recorded 5,614 souls, the first transcontinental line between Sacramento and Omaha joined at Promontory Point, an event that foreshadowed significant growth of every conceivable type. The Southern Pacific, the successor to the Central Pacific, quickly established as its objective the control of all means of transportation to and within California, an ambition which local citizenry and other business interests were determined to frustrate.

In extending a trunkline from San Francisco to Los Angeles, the Southern Pacific acquired certain perquisites, including the pioneer rail line to the harbor area. Since the company controlled the pier and the lighterage equipment, it established a temporary monopoly. With the interest of the Southern Pacific in all-rail hauls between Los Angeles and San Francisco the company neglected development of shipping facilities in the Los Angeles area. Other business interests challenged the company by founding the town of Santa Monica several miles north of San Pedro on Santa Monica Bay, where they constructed an excellent deepwater pier, and linked those harbor facilities to Los Angeles by a railroad line. The Southern Pacific countered this challenge by absorbing that company and then destroying the pier. To forestall competition from any southern transcontinental railroad, the Southern Pacific established the first direct rail linkage of southern California to the rest of the country by connecting with the Texas and Pacific Railroad.

In the mid 1880's a second transcontinental railroad, the Santa Fe, entered Los Angeles and San Diego. While San Diego had an excellent natural harbor, the town was too far away from the population center of southern California to offer substantial competition to potential harbor facilities within the San Pedro or Santa Monica Bay. In 1887 the Santa Fe opened a rail line from Los Angeles to Port Ballona, now Playa del Rey, but dredging efforts by the company to open a channel to the Ballona slough ended in dismal failure. Colonel Mendell verbally supported this entire harbor project. In 1888 the Santa Fe connected Los Angeles with Redondo, where a real estate company had built a substantial pier which took advantage of a submarine canyon to allow deep-draft vessels to unload their cargoes directly upon railroad cars, thus eliminating the expense and difficulties of lighterage required at San Pedro.

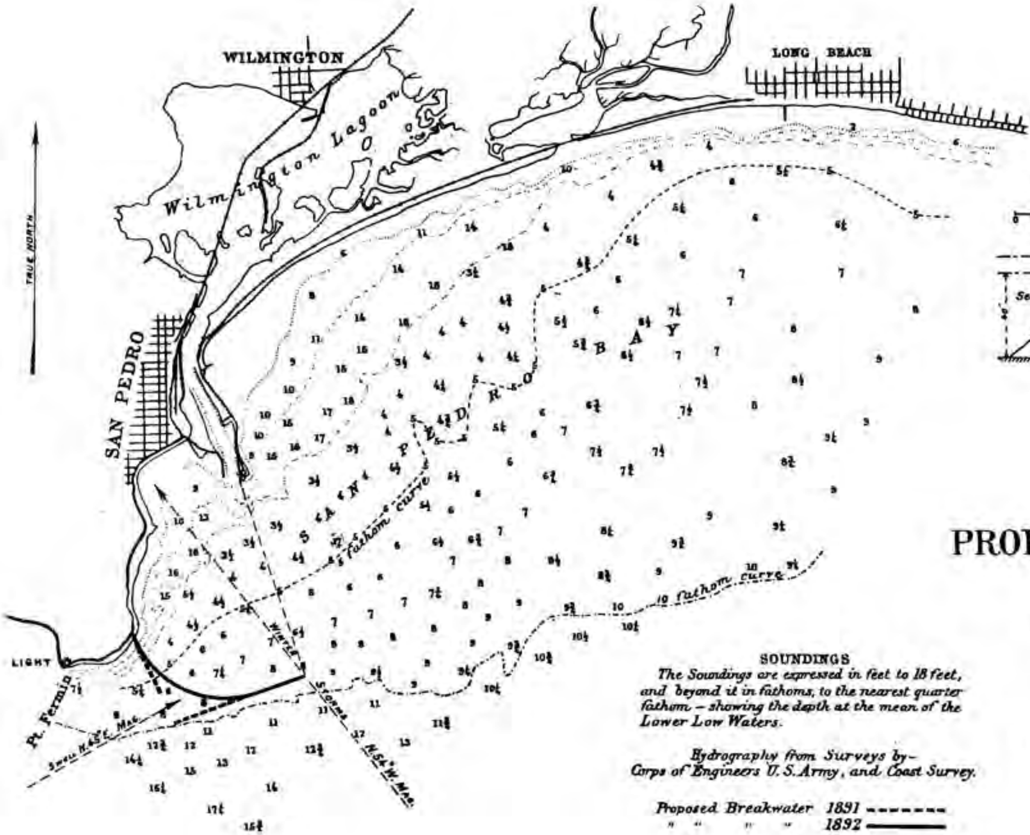
This railroad rivalry produced a rate war which promptly led to a fantastic increase of population and economic growth in the Los Angeles area. In 1886 the population was recorded at 15,000 in the City of Los



Angeles and 50,000 in the metropolitan region. In less than 2 years the figures jumped to 70,000 and 200,000, respectively. Commercial activities also zoomed at San Pedro for tonnage figures reached over 500,000 tons in 1888 in contrast to about 180,000 tons in 1881.

With only unprotected anchorage at San Pedro and Redondo, and with San Diego harbor impractical because of distance, local interests recognized that the future development of the Los Angeles area required a protected major deepwater harbor. Business interests began the campaign to obtain funds from Congress for that harbor at San Pedro. Congress authorized a preliminary survey in 1886.

Upon completion of that survey Colonel Mendell, who previously had rather casually suggested that building an artificial harbor at San Pedro was a worthy project for the Federal government, now became a



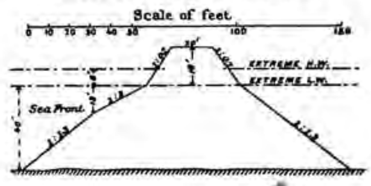
SOUNDINGS

The Soundings are expressed in feet to 18 feet, and beyond it in fathoms, to the nearest quarter fathom — showing the depth at the mean of the Lower Low Waters.

Hydrography from Surveys by— Corps of Engineers U. S. Army, and Coast Survey.

Proposed Breakwater 1891 - - - - - - -
" " " 1892 ————

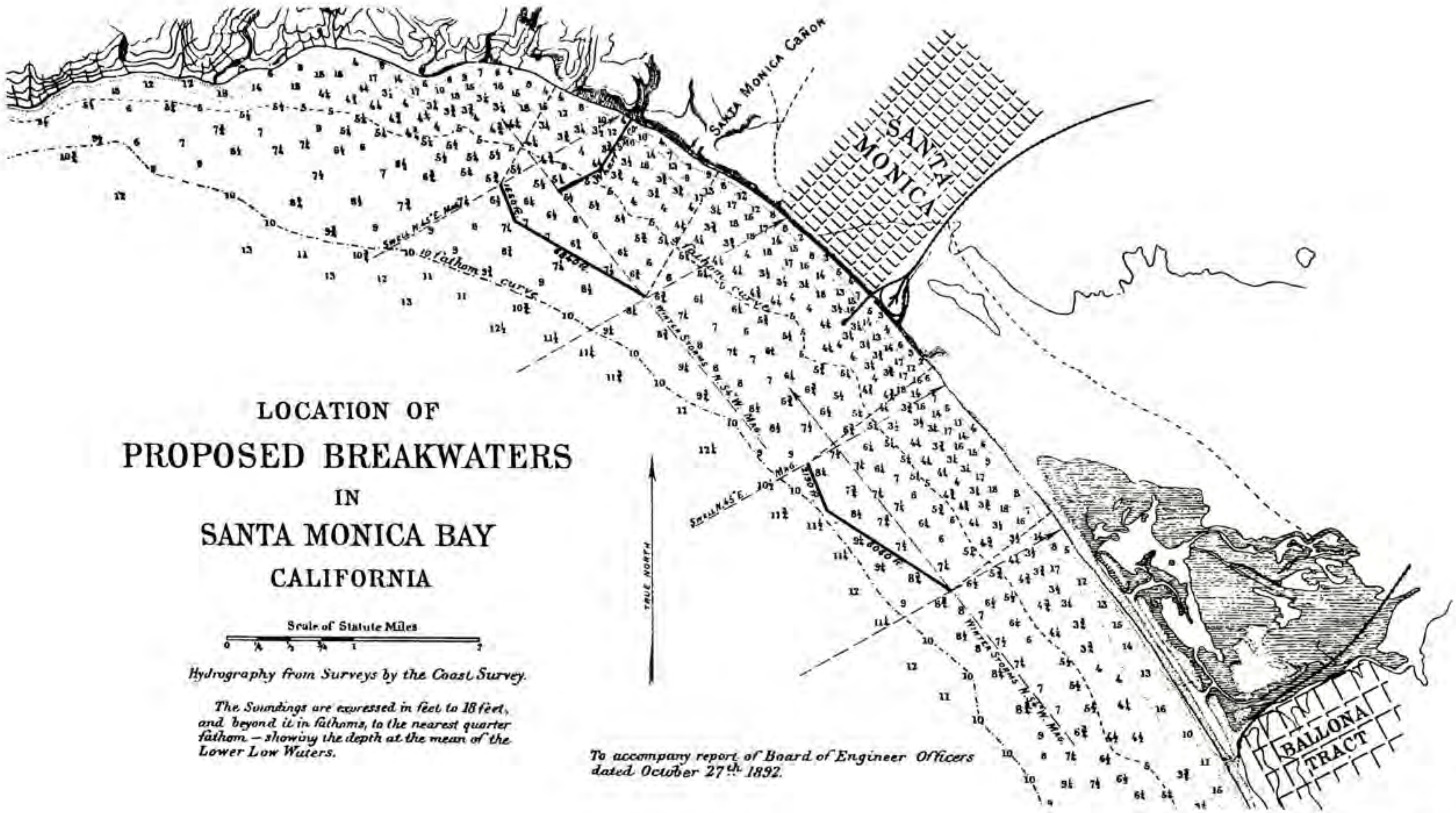
Cross Section of Breakwater



LOCATION OF PROPOSED BREAKWATER IN SAN PEDRO BAY CALIFORNIA

Scale of Statute Miles

To accompany report of Board of Engineer Officers dated October 27th 1892.


LOCATION OF
PROPOSED BREAKWATERS
IN
SANTA MONICA BAY
CALIFORNIA
Scale of Statute Miles
Hydrography from Surveys by the Coast Survey.
The Soundings are expressed in feet to 18 feet, and beyond it in fathoms, to the nearest quarter fathom – showing the depth at the mean of the Lower Low Waters.
To accompany report of Board of Engineer Officers dated October 27th 1892.
TRUE NORTH
SANTA MONICA CAÑON
SANTA MONICA
BALLONA TRACT
10 fathom curve

vigorous proponent for developing that harbor. In 1888 he submitted the first breakwater project for San Pedro Bay to Congress. His associate, Major W. H. H. Benyaurd, designed a breakwater to consist of two arms separated by a gap of 1,000 feet, the inner arm to extend from the 3-fathom curve just off Point Fermin to approximately the 9-fathom curve with the outer arm at a tangent nearly on that curve, at an estimated total cost of $4,045,700. This proposal encountered formidable opposition from the influential chairman of the Senate Committee on Commerce.

In the fall of 1889 the U.S. Senate Committee on Commerce, responsible for all harbor projects, came to the west coast on an inspection trip. Escorted by Senator Leland Stanford, President of Southern Pacific, and an ebullient delegation of the Los Angeles Chamber of Commerce, the committee junketed to San Pedro. To their dismay Senator William B. Frye, a tough-minded man from Maine and chairman of this important committee, unable to visualize what the imaginative Angelenos saw at San Pedro, denounced the project. Moreover, after a visit to Santa Monica, also under consideration, he concluded that this was the better site for a deepwater harbor, which made Santa Monica a formidable rival to San Pedro. Thus the first proposal for a harbor of refuge and commerce collapsed, but local interests were not that easily stopped.

In 1890 the Secretary of War under instructions of a patient Congress appointed Colonel Mendell and Lieutenant Colonels G. L. Gillespie and W. H. H. Benyaurd "to examine the Pacific Coast between Points Dume and Capistrano with a view to determining the best location for a deepwater harbor, to prepare a project and to estimate its costs." After detailed analysis this board rejected all sites except San Pedro on the basis that a harbor there would effect "better protection both from prevailing winds and from dangerous storms . . . at less cost for equal development of a breakwater."

The board also proposed a breakwater of two arms with the inner arm extending from shore to the 6-fathom curve with an opening of 1,300 feet which placed the outer arm at approximately the same location as in 1888, but 500 feet longer, at an estimated cost of $4,137,591.

When the Mendell report was referred to the Senate Committee for implementation, no one anticipated any difficulties. Formidable opposition arose from an unexpected source – the Southern Pacific. At the committee hearing Senator Frye read a telegram from the Chief Engineer of the Southern Pacific, the contents of which challenged the selection of San Pedro on the grounds that the Mendell Board neglected

to report that, because of the rocky nature of the bottom at San Pedro, there was insufficient holding ground for ships, and recommended Santa Monica as the site for the harbor instead. Actually the Mendell group had considered this problem and found sufficient holding ground. The telegram accomplished its purpose of destroying a favorable recommendation of the San Pedro project. Now began what is called the "Free Harbor Fight" between community interests and adverse private interests with the Army Engineers swept into the contest.

For many reasons the Southern Pacific decided upon re-opening the whole issue of deep water facilities in the Los Angeles region. One factor resulted from a change of leadership within the Southern Pacific, for Collis P. Huntington replaced Leland Stanford as president, which deprived San Pedro of an important supporter. Around 1881 Colonel Mendell and Stanford in a long discussion settled as far as they were concerned the need for the harbor and its location. By 1888 the Southern Pacific had a monopoly on the western side of Wilmington Harbor and commenced the building of a wharf from Point Fermin eastward into the outer harbor. But the Federal Government challenged the legality of the right-of-way of the railroad which crossed a "Government Reservation" without a permit. The proposed pier also would be in danger during winter storms. In addition, Port Redondo had made serious inroads into use by coastal shipping of the facilities of San Pedro and the Southern Pacific. Moreover, in its own private preserve the Southern Pacific faced another competing railroad which removed any possibility of monopoly conditions at San Pedro. On the other side of the harbor other business interests in 1891 purchased picturesque Rattlesnake Island, renamed it prosaically Terminal Island, and built the Los Angeles Terminal Railway via the new town of Long Beach to Los Angeles. In addition there was a rumor that this new railway intended to establish a connection with the Union Pacific, not a pleasant prospect for the Southern Pacific. With his characteristic boldness, Huntington abandoned the Point Fermin project, built a magnificent pier, "the longest of its kind in the world," secured a right-of-way along the entire Santa Monica shoreline to the new pier, and now sought to obtain breakwater protection at Federal expense for the "long wharf."

A bewildered Congress authorized the Secretary of War to appoint a board of five engineer officers to report which was the more eligible, San Pedro or Santa Monica, for a harbor to accommodate the largest ocean-going vessels and the defensive needs of the country.

In recognition of the powerful political influence of Huntington, with the advice of Brigadier General Thomas Lincoln Casey, the Chief of Engineers, the Secretary of War appointed Colonel William P. Craighill, Lieutenant Colonels Henry M. Robert and Peter C. Hains, and Majors

Thomas H. Handbury and C. W. Raymond, a very prestigious group. Craighill and Robert both rose to the position of Chief of Engineers, while Handbury served as District Engineer of LAD. General Robert is renowned for his valuable "Robert's Rules of Order." At the public hearing in Los Angeles in September 1892 testimony indicated why the Southern Pacific had shifted its position. After consideration of all factors the Craighill Board decided unanimously in favor of San Pedro and proposed a continuous breakwater 8,500 feet long on a curve to the line of the outer arm of the 1890 project and then a short distance along that line to the end at an estimated cost of $2,885,324. Once again it appeared that the question was settled but the Commerce Committee refused to appropriate any money in support of the report.

The Southern Pacific completed the "long wharf," cleverly gave it the name Port Los Angeles, and began a campaign to gain public opinion in favor of its plan. Angelenos were not pleased with the prospect of relying on the Southern Pacific for the growth of their favorite project, the City of Los Angeles. Huntington failed to obtain public support from the local interests in Los Angeles, for he encountered equally skilled protagonists, such as Harrison Gray Otis, the publisher of the Los Angeles Times, the Free Harbor League, and Senator Stephen M. White, who supported the San Pedro site. Huntington's influence on the Senate Commerce Committee prevented any decision being made with respect to the Craighill recommendations. With the country in economic doldrums, no money was available for the project. In 1896 Huntington out-maneuvered his opponents by an amendment to a proposal to dredge the inner harbor at San Pedro, an amendment which provided $3,098,000 for a breakwater in Santa Monica Bay. After 5 days of debate which attracted national attention, Senator White reversed the situation by obtaining an amendment which appropriated $2,900,000 for a breakwater and the appointment of another engineering board of unprejudiced members to decide the location. This time the decision of the board would be final. President Grover Cleveland vetoed the entire River and Harbor Act but Congress over-rode his veto. The exclusion of Army engineers from the new board was an unjust and galling reflection on the Corps of Engineers, but their exclusion also indicated the impossibility of influencing the technical judgment of engineer officers. The Corps received its vindication from the new board. Although Senator Stephen M. White was rewarded justifiably for his role in developing San Pedro, the public has never properly recognized the Army engineers for their never-ending role in that harbor development.

In October 1896 President Cleveland appointed Rear Admiral John G. Walker of the Navy as chairman, Augustus F. Rodgers from the Coast and Geodetic Survey and three non-governmental civilians – George S. Morrison, William H. Burr, and

Richard P. Morgan – to the harbor selection board. Morgan, a Southern Pacific man, filed a minority report which favored Santa Monica, but the majority report of the Walker Board recommended "in favor of San Pedro as the location for a deepwater harbor for commerce and of refuge in southern California."

Huntington still refused to yield. With the assistance of the Secretary of War, Russell A. Alger, he delayed the project. Pressure from the U.S. Senate and hundreds of letters produced a request from President William McKinley to Alger which directed the latter to advertise for bids. Sealed bids were opened by Major E. L. B. Davis in the San Francisco office of the U.S. Army Corps of Engineers on February 10, 1898. Not until July did Alger approve a contract for the work. The low bid by Heldmaier and Neu of Chicago was for $1,303,198, less than half the estimated cost. In the Senate the Santa Monica supporters failed in efforts to expend the balance of about $1,600,000 pro rata upon both Santa Monica and San Pedro.

Although the harbor site was settled, innumerable difficulties, human and natural, arose during the construction of the breakwater. Not until April 26, 1899 did the contractor dump the first load of rock from Catalina Island. To celebrate this auspicious occasion the bay area communities held a Free Harbor Jubilee. As a fitting climax to the speechmaking, feasting, firing of cannon, and parading, President McKinley pressed a gold telegraph key which failed to release the first barge-load of rock, a task accomplished by hand. The celebration turned out to be premature as the breakwater work progressed so slowly that the Corps cancelled the contract on March 19, 1900.

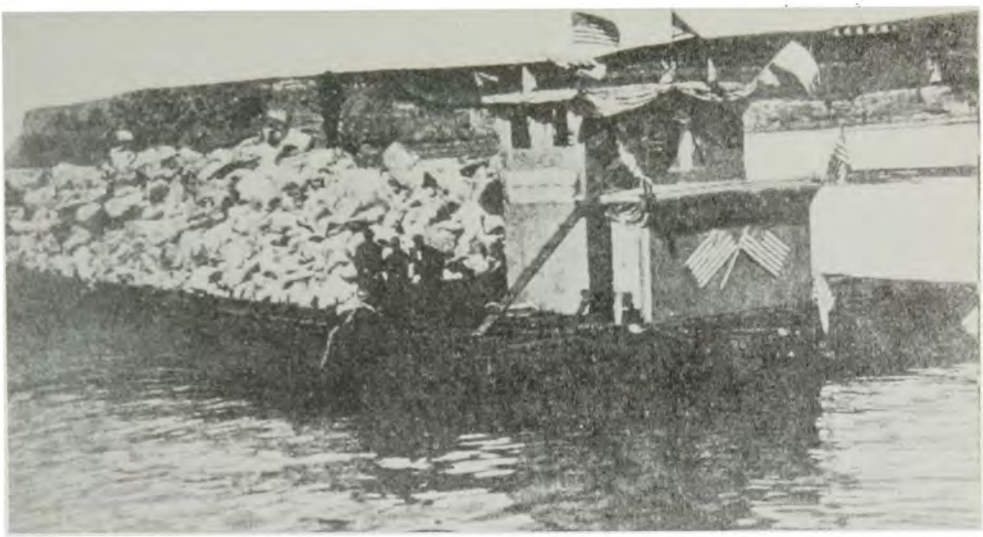
Alerted by the experience of the first contractor, the second prudently bid higher, $2,375,546.50, and resumed work on August 29, 1900. In spite of his prudence this contractor had to pour out his own financial resources composed of credit from friendly creditors, profits from his other construction contracts, and personal savings to complete this project.

To facilitate the construction and recognizing the ultimate impact of the harbor on Los Angeles and its vast tributary region, the Corps of Engineers created the Los Angeles District with Captain James J. Meyler, CE, as the first District Engineer. His first contact with the area had occurred in 1891 as project officer for the Wilmington Harbor.

The design and location of the breakwater followed the recommendations of the Walker Board Report. A detached breakwater beginning in four fathoms of water approximately 1,900 feet from shore

was constructed, with the first section a 3,000-foot tangent in a southeasterly direction followed by a curve 1,800 feet long, with a radius of 1,910 feet, and concluding in another tangent 3,700 feet approximately along the eight fathom contour. During construction the practicality of leaving the 1,900-foot gap between the structure and the shore was reconsidered. Among the original purposes were the provision of a secondary entrance and promotion of free circulation of water on the premise that sewage and debris would leave faster and shoaling inside would be retarded. However, rocks and a kelp bed off Point Fermin made the gap uninviting as an entrance and storms shaped rough water inside. To obviate these faults, a project to close the gap was authorized in 1910 and completed in 1912. Thus, instead of the 8,500 feet as planned the completed structure was 9,250 feet long, containing nearly 3,000,000 tons of rock and costing almost $3,000,000.

In 1899, rock for the breakwater begins to arrive. (Security-Pacific National Bank Collection) (also Title Insurance and Trust Co. Collection)



The first load of rock is dumped off Point Fermin, beginning the construction of the breakwater. (Security-Pacific National Bank Collection)

Dumping rock from railroad car on trestle, San Pedro Breakwater, 1902.

San Pedro breakwater under construction, 1902. (Title Insurance)

San Pedro Harbor, completed breakwater. (Title Insurance)

Another aspect of the original design caused concern. With the base of the superstructure the same width as the top of the substructure there was a lack of shoulder. To prevent possible damage to the structure, berms of about 4 feet were placed both on the harbor and ocean sides, with a deep layer of unshaped stone added to the shaped-stone foot of the berm on the ocean side.

In closing the gap between the original breakwater and the shore, the design of the Walker Board was not utilized. Instead a substantially cheaper design, evidence of the cost-consciousness of the Corps, provided a random mound of the same top height and width. Moreover, this random mound endured the seas equally well because less water passed over its top. The extreme irregularity of this part of the breakwater allowed surges of seawater to enter through large gaps in the wall rather than spilling over the top. The special construction with rectangular blocks provided steep sided slopes, thus narrowing the substructure. With this design, major cost reductions, particularly for projects in deepwater, were possible.

As controlling officer of the San Pedro harbor project, Captain Meyler was under constant pressure. For example, the *Los Angeles Times,* February 5, 1901, charged corruption in connection with the breakwater work, alleging that Captain Meyler and his subordinates allowed the contractor to place into the breakwater rock of an inferior quality from the Chatsworth Park quarries. Further allegations insinuated that during the serious illness of Captain Meyler his subordinates were lax and inefficient in discharging their responsibilities. Promptly the Chief of Engineers, Brigadier General John M. Wilson, dispatched Colonel Jared A. Smith, Division Engineer of the Pacific Division, of which LAD was a part, to conduct an investigation. With Captain Meyler too weak to accompany Colonel Smith, D. E. Hughes, assistant engineer, represented LAD. Colonel Smith complimented Hughes for his extensive knowledge of stones and of the situation at San Pedro. Colonel Smith completely demolished the allegations. More pleasing to the Corps was the investigation by a committee of the Los Angeles Chamber of Commerce under the chairmanship of Harrison Gray Otis, publisher of the *Times,* which corroborated the findings of Colonel Smith. The *Times* published the results of the investigations, thus removing the misapprehensions concerning the quality of the rock used in the breakwater construction.

Among the factors which influenced the various boards in locating the harbor at San Pedro was the existence of a magnificent inner harbor which would complement the outer harbor, thus leading to a harbor not only of refuge but of commerce. The Walker Board stated "that the possibilities for the further development of the interior harbor are equal

to any demand upon it which the future can be expected to make." Wisely Congress in the Act of March 3, 1899 ordered a complete survey of the whole harbor area.

In compliance Captain Meyler sent F. C. Turner, Assistant Engineer, to make the survey. The latter's findings resulted in a recommendation for a project to dredge the inner harbor to a depth of 30 feet. While the project report recognized that existing demands of commerce did not justify extensive improvements at great expense to the Federal government, nevertheless the report concluded that on the basis of the vast and unlimited commercial potentialities of a port located in the midst of a fertile agricultural region, with undeveloped mineral resources, rich oil fields, excellent railroad connections and expectations of increasing Asiatic trade, the expenditures were justified. Also, in contrast to local interests, the Army engineers advocated a single harbor concept in San Pedro Bay to handle both coastal and ocean shipping. In spite of the favorable recommendation numerous difficulties delayed improvement of the inner harbor at Wilmington. Finally, in the River and Harbor Act of 1901, the long delay in improving the inner harbor ended with an appropriation of $550,000 to reinforce a weak portion of the east jetty and to dredge that part of the harbor extending up to and including the turning basin south of Mormon Island to a depth of 24 feet and an average width of 400 feet. Fortunately for future development of both the Los Angeles and Long Beach Harbors, LAD obtained approval to delete from the project the building of a dike to divert the Los Angeles River from Wilmington Lagoon. This action left open the slough leading to Long Beach, which ultimately was converted into the Cerritos Channel. In 1905 to facilitate the dredging of the inner harbor, LAD acquired the dredge *San Pedro*.

During the first decade of the 20th century, LAD continually was involved in the contest between private interests and, specifically, the City of Los Angeles. The Corps of Engineers had the major responsibility to establish harbor lines necessary for the preservation and protection of harbors. By 1900 the Southern Pacific had, through perversion of the law, gained title to submerged tide and marsh lands, which would have enabled the railroad interests to establish a monopoly position at San Pedro Bay and which represented an encroachment on harbor lines. The aggressive City of Los Angeles which desired municipal control of the harbor launched a two-pronged attack in the State courts and in Congress on the railroad interest. This controversy did not obtain national publicity like the breakwater battle, but still it was tense, bitter, and prolonged. During the protracted struggle the District Engineers, particularly Captain Amos A. Fries (February 1906 – August 1909), produced modifications to previous harbor plans which led to a better development of the San Pedro Harbor.

In response to the local citizenry, Congress authorized a Harbor Line Board to which were appointed Lieutenant Colonel John Biddle, Division Engineer, Captain Fries, and Lieutenant Charles T. Leeds, assistant to Captain Fries. Captain Fries later became a Major General, serving as Chief, Chemical Warfare Service, in France during World War I. Lieutenant Leeds, later a Colonel, served as District Engineer, and upon retirement continued his connection with harbor development as an important consulting engineer in Los Angeles. This board delineated two large basins, one on each side of the turning basin, but the Chief of Engineers rejected the delineation on the grounds that the engineers had no authority to establish harbor lines beyond the turning basin. Not deterred, local interests submitted an application for a permit to develop the area east of the turning basin. Although LAD recommended rejection of the application, the District submitted a superior plan for the development of the inner harbor which achieved the objectives of local interests.

Of considerable significance is the underlying philosophy behind this sagacious plan evolved by the staff of LAD. In February 1907 David E. Hughes elaborated:

"Since neither tidal prism nor anchorage area would be of any use in this inner harbor, it would be an inexcusable waste to dredge more than is sufficient for the easy passage, berthing and turning of ships, and the rest of the reserved area should be reclaimed under government control for the regulation of commerce. Such reclamation is also desirable for the reason that, through providing room near at hand for the disposal of dredgings, it would greatly reduce the cost of excavating the channels and slips."

"The land reclaimed should never be alienated, but held as a public water front under control of Federal or State authority for the regulation of commerce."

Expressing Federal approval, the Secretary of War "reaffirmed the authority to establish lines in navigable waters in advance of improvement and regardless of ownership of the underlying land," and Congress authorized execution of the plan in the River and Harbor Act of 1910.

In line with the LAD contention expressed by Hughes that private claims to tidelands were held illegally, the City of Los Angeles in the name of the State insituted a legal suit to recover the patented lands in Wilmington Bay. In 1912 the California Supreme Court upheld the Superior Court which returned to public control the bulk of the tidal lands.

During the litigation the City of Los Angeles by a series of complicated maneuvers placed the San Pedro Harbor area within city limits. To connect the city proper to the harbor, the city annexed an area a half-mile wide, locally known as the "shoestring strip." In 1909 the communities of Wilmington and San Pedro voted themselves into Los Angeles. With the Panama Canal nearing completion and the consequent broadening of commercial prospects for ports on the Pacific Coast, the City of Los Angeles to improve its competitive position resolved its remaining differences with the railroad interests.

These actions of the City of Los Angeles were complemented by State action which on May 1, 1911 granted to the City of Los Angeles title to the tidal and submerged land within the "consolidated city." Thus almost absolute control and ownership of the harbor and water front was achieved by the municipality which guaranteed the use of the harbor for the benefit of the people.

Having cleared away all major obstacles the authorities and people of Los Angeles, with the full cooperation of LAD, were in a position to establish one of the finest man-made harbors in the world.

The Los Angeles Harbor is only part of the port terminal entity, for the Long Beach Harbor is as significant though administratively and politically separate. Except for its perennial brotherly squabbling with Los Angeles, the Long Beach Harbor developed without the struggles which plagued its neighbor.

Long Beach

Long Beach Harbor, constructing Pier A to serve as an ammunition dock, 1943.

Although the Long Beach Harbor began in 1906 under private auspices, it soon came under the control of the City of Long Beach. After purchasing 800 acres of marshlands and tidal sloughs, the Los Angeles Dock and Terminal Company secured a permit from the War Department to develop what became ultimately the inner harbor of Long Beach. Under its plan the harbor consisted of an entrance channel protected by jetties on each side, an interior turning basin, and three navigation channels which extended northerly and easterly from the basin. Three years later the entrance channel through the barrier beach was opened to the outer bay. All of this well-conceived project survives as the inner harbor except the north channel. The company foundered under the financial burden of constant dredging which was required to remove the large quantities of suspended sediment deposited by the floodwaters of the Los Angeles River, particularly in 1916. Fortunately, because of the vision and perseverance of its citizens, early Long Beach was prepared to assume the responsibility for the harbor. Back in 1909 a population of less than 18,000 approved a bond issue for $245,000 for acquiring frontage land and built a terminal on it. Then the city accepted a deed from the company for all its waterways and 5 acres of

Long Beach Harbor in 1959.

land adjoining the city pier. Thus a small city proposed to match its indomitable spirit against the resources of Los Angeles in a friendly rivalry of port development.

Having exhausted public-owned frontage on the inner harbor, Long Beach turned in 1924 to the designing and development of an outer harbor. During the expansion of this harbor, Long Beach reclaimed nearly 1,000 acres of land by filling seaward from the original shoreline in water depths of 40 or more feet. Today perhaps the most modern and sophisticated facilities in the world grace these fills, with additional terminals planned.

By this time it was apparent to all concerned that the communities of Los Angeles and Long Beach should coordinate their activities. All the special engineer boards concerned with the location of a deepwater harbor had envisaged the creation of a single harbor of commerce and refuge. Efforts to include the twin harbors under a single port authority ended in failure.

Nevertheless, cooperation between the two communities and LAD was sufficient to resolve many common problems.

One immediate problem involved the permanent diversion of the floodwaters of the Los Angeles River away from the harbor areas. Another problem concerned a direct channel connection between the two inner harbors. One early proposal for river diversion was providentially forestalled, for it would have consisted of a dike forcing all floodwaters out where later the Long Beach Inner Harbor was built. If that had occurred, there would be no two inner harbors to link. Again, providentially, floods in 1914 and 1916, which produced major silting to the harbor as well as bankrupting the Los Angeles Dock and Terminal Company, expedited diversion of the river. To accomplish this, a short intercepting dike from the high land at Dominguez and approximately 5 miles of leveed channel from there to the ocean were constructed, with completion in 1923. Responsibility for the operation and maintenance of this project was turned over to the Los Angeles County Flood Control District, another by-product of the floods of 1914 and 1916.

Not the least among the contributions of Captain Fries to the development of the greater harbor at San Pedro Bay was the establishment of a direct water connection between the inner harbors. In 1908 this farsighted engineer noted that the narrow, sinuous channels of the Cerritos Slough were legally subject to improvement for navigation. He negotiated with the railroad company which owned the shoreland along this slough to obtain a 400-foot wide strip for the Federal

Government to provide the connecting channel between the two harbors. Within this strip, augmented in 1918 to 600 feet, LAD and Long Beach combined their dredging efforts to establish a channel 200-feet wide between the harbors. Later the Cerritos Channel was expanded to its present 300-foot width.

Stimulated by its vision of what the future demands of commerce and trade would be, the Los Angeles Board of Harbor Commissioners in 1912 began agitation for widening the entrance channel to a minimum of 1,000 feet with a minimum depth of 30 feet and an extension of the breakwater to protect the outer harbors of Los Angeles and Long Beach. Prolonged discussion, political bickering, and World War I delayed the project for many years. Upon completion of the Panama Canal in 1914 intercoastal shipping increased rapidly, but the outbreak of the war in Europe drove American shipping to the Atlantic where it was sorely needed to meet the U-boat challenge. Shortly after the Armistice of November 1918 a phenomenal growth of harbor activities commenced which continues to this date. From less than 150,000 tons of cargo a month, primarily lumber, at the Armistice, the volume reached more than 2-1/2 million tons a month in less than 4 years. Unprecedented development in the vicinity of Los Angeles and Long Beach, plus inadequate storage and refining facilities in southern California, resulted in a parade of tankers to Panama which placed the Panama Canal on a profit paying basis. Thus in 1923 this great harbor was established as the leader of all west coast harbors in total tonnage handled, and today it is still unchallenged. The Port of Los Angeles labels itself the "Cargo Capital of the West."

Under the pressure of increasing use, harbor development became a necessity. In 1928 LAD completed the removal of Deadman's Island and the reclamation of Reservation Point in a project which broadened the Main Channel of the Los Angeles Harbor to a minimum of 1,000 feet up as far as the turning basin.

Although Congress did authorize, in 1925, a breakwater extension made entirely of rock, Congress also spelled out certain conditions for local cooperation. Among the most important and troublesome were contribution of one-half the first cost, estimated to total $14 million; organization of a port district with full jurisdiction over all ports and facilities; creation of a single belt-line railroad; and closing of a 1,500 foot section of Cerritos Channel which would end Terminal Island as an island. None of these conditions were met. However, the City of Long Beach constructed a length of breakwater in complete accordance with the project, with the approval of the Chief of Engineers, and hoped to qualify its cost as part of the local financial contribution.

Los Angeles Harbor, Main Entrance. Widening channel to 1,000 feet and 35-foot depth; Deadman's Island; removal of reclamation of Reservation Point, March 30, 1927.

Los Angeles Harbor. In the foreground are the remainder of Deadman's Island, the dredge, *San Francisco* No. 2, and trestles supporting boring rigs for blasting holes and jetty; in the distance the southeasterly corner of fill pipe line, the suction dredge, and the government breakwater, June 9, 1928.

Same project. The view is northwesterly. In the right foreground is the west bulkhead and fill, and in the left foreground is a new water area, site of former Deadman's Island. In the left middleground is the new channel area with dredge *McMullen* and pipeline to fill, clamshell dredge, and barges for obtaining project depth and clean-up, May 5, 1929.

Work is in progress to remove the sunken steel tanker, *Washtenan,* at Berth 94, Los Angeles Harbor, May 2, 1929. LAD executed its responsibility to remove obstructions to navigation.

To ascertain whether any changes in the existing project were deemed desirable, Congress established a review board to which the Chief of Engineers appointed three engineer officers, Major C. S. Ridley, President, Major J. O. Arthur, and Major C. P. Gross, the latter also the District Engineer. (Major Gross capped a distinguished career by rising to the rank of Major General and becoming the first commanding officer of the Transportation Corps organized during World War II.) After a public hearing, a very frustrating one, held in Los Angeles on June 1, 1928, the board concluded that the conditions set by the project for local cooperation were sound and essential to the creation of a national port. Since they believed that independent development of the two harbors would result in friction and inefficiency, the board, while recognizing that the Federal Government might not be able to prevent this, felt that it should not be encouraged by Federal expenditures.

At the public hearing all interested parties favored a breakwater built wholly at United States expense, disagreed on location, and differed on port unity. The Los Angeles interests favored the formation of a unified port district, but the Long Beach representatives were unalterably opposed. Confronted with an impasse, the Board recommended that the project temporarily be dropped and that Long Beach be reimbursed for up to one half the costs of the breakwater constructed by that city.

Out of the hearing emerged a momentous recommendation by the board that "when the building of a breakwater can be constructively considered. . . the trace and cross section proposed by the district engineer . . . should be made the basis for the physical design." Out of this suggestion buried in the committee report emerged ultimately the Los Angeles-Long Beach detached breakwater, a unique contribution in breakwater construction: it is of composite type consisting of a random-rock mound superimposed on an earthen core.

This proposal originated in the mind of the invaluable D. E. Hughes back in 1925. At that time, in anticipation of early construction of the breakwater, Major H. A. Finch, District Engineer, called on Hughes for a draft of specifications for materials and cross sections. Aware that the cost factor was a major stumbing block for the project, Hughes designed a composite breakwater which lessened the cost considerably.

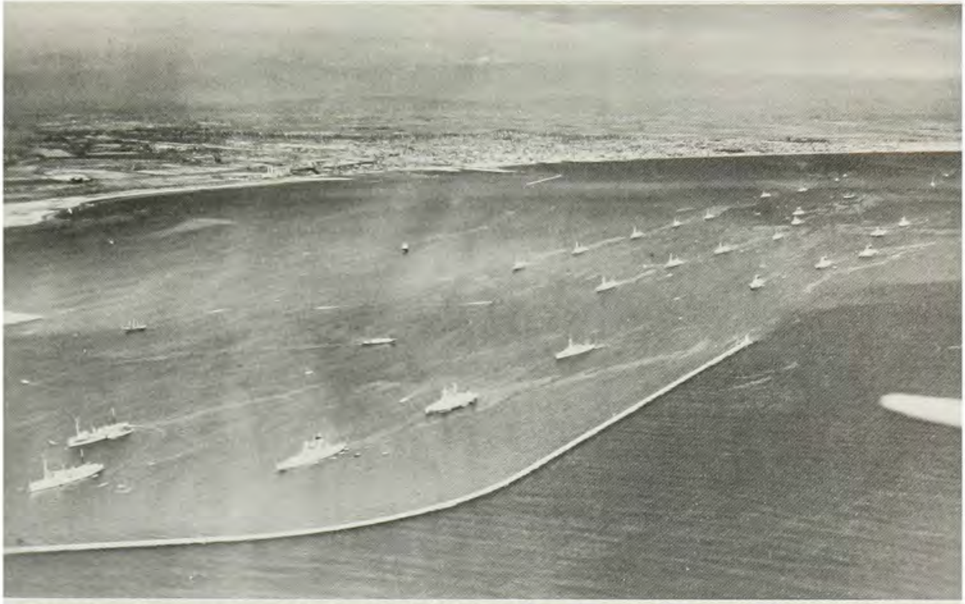
Hughes always seemed to store in his mind observations by other engineers. He recalled that in 1901 Colonel Jared Smith, Division Engineer, remarked that he would use a cheaper lasting material for both the base and hearting of the proposed breakwater in place of rock. In criticizing the cost estimate contained in the Downing Report of 1920, an eastern consulting engineer also had stated that one half the cost could be absorbed by throwing up a ridge of dredging which then would

be capped with stone. However, the report of 1924 by Major E. D. Ardery, District Engineer, still called for an expensive all-rock breakwater. In preparing the design in 1925 Hughes had some lingering doubts about the safety of the composite breakwater, but in his report, October 28, 1928, to Major Gross, District Engineer, and again in a report dated December 11, 1929, he concluded: "The experiments, analysis and calculations of 1928 removed any personal doubt as to suitability of the proposed dredging for use in a composite breakwater up to any height practicable to adopt under working conditions in breakwater construction with floating plant."

Though interested engineers in San Pedro, Long Beach, Los Angeles, and San Francisco subjected Hughes' data and deductions to critical analysis, they could find no confutation.

In 1930 Congress authorized a new breakwater project which adopted the Hughes' composite design and eliminated the arm of the breakwater to the shore on the west side of the flood control diversion channel mouth. By utilizing dredgings from project areas in Los Angeles Outer Harbor for the base and hearting of the breakwater instead of using all rock, LAD reduced the total estimated cost to $7 million, the amount that the Federal Government was prepared to assume in the first project, which logically eliminated the condition providing for local contribution. With reluctance the Government also dropped the other conditions. While the dominant interests of the City of Los Angeles overwhelmingly desired port unification, they were opposed adamantly by the City of Long Beach which was reluctant to surrender control of a harbor provided entirely through its own unaided efforts. However, Wiliam J. Herron, now retired Chief of Coastal Engineering Branch, Los Angeles District, stated unequivocally that a healthy competition has produced two excellent ports. Moreover, with the discovery of oil in 1936 on city-owned property Long Beach has had the financial resources to match the superior resources of Los Angeles since that time.

Starting with an experimental earthen mound on site in 1932, the composite breakwater was completed in 1937. Among the apt disciples of Hughes was H. W. McOuat, who functioned as an able successor to Hughes in furthering the development of harbors along the coast of southern California. In 1939, McOuat, at the direction of Lieutenant Colonel Edwin C. Kelton, District Engineer, prepared a complete record of this unique contribution of LAD to engineering: "The Design and Construction of a Composite Detached Breakwater." Full development of the outer harbor was made feasible with the addition of two detached breakwaters in 1942 and 1949. The complete outer breakwater extended to a point opposite Alamitos Bay is the longest breakwater in the world, nearly 47,000 feet in length, including two entrances.



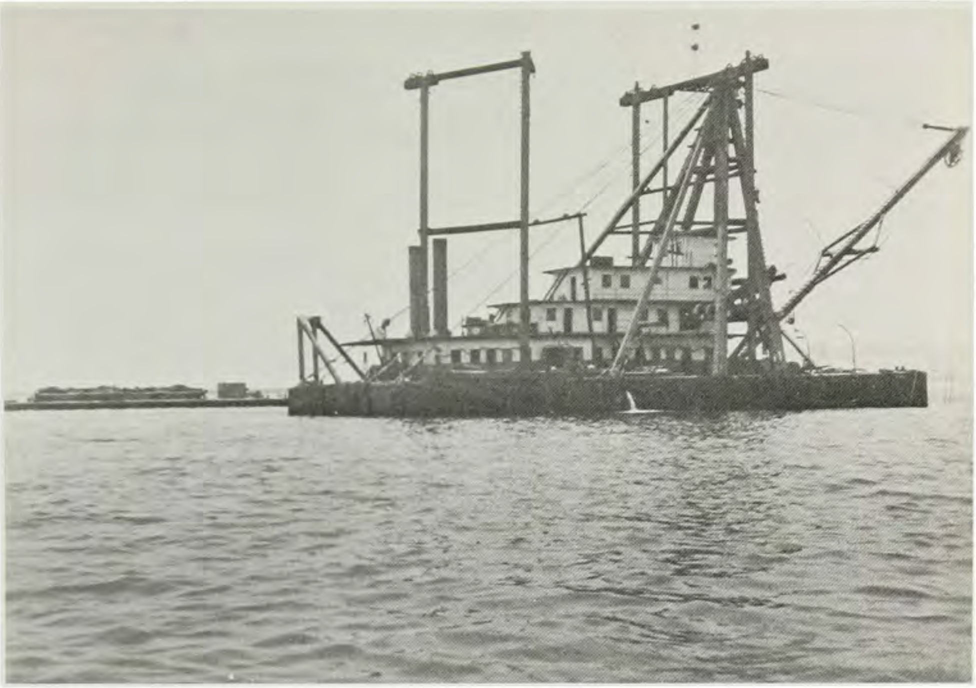
Detached breakwater, 1932-1938. This view shows the condition of the San Pedro Harbor prior to construction of the detached breakwater. The majority of the fleet, which is shown anchored here, is exposed to the full force of the open sea.

This is a view from offshore looking up the coast toward San Pedro which shows the partially completed detached section of the breakwater in the foreground with work in progress at two points.

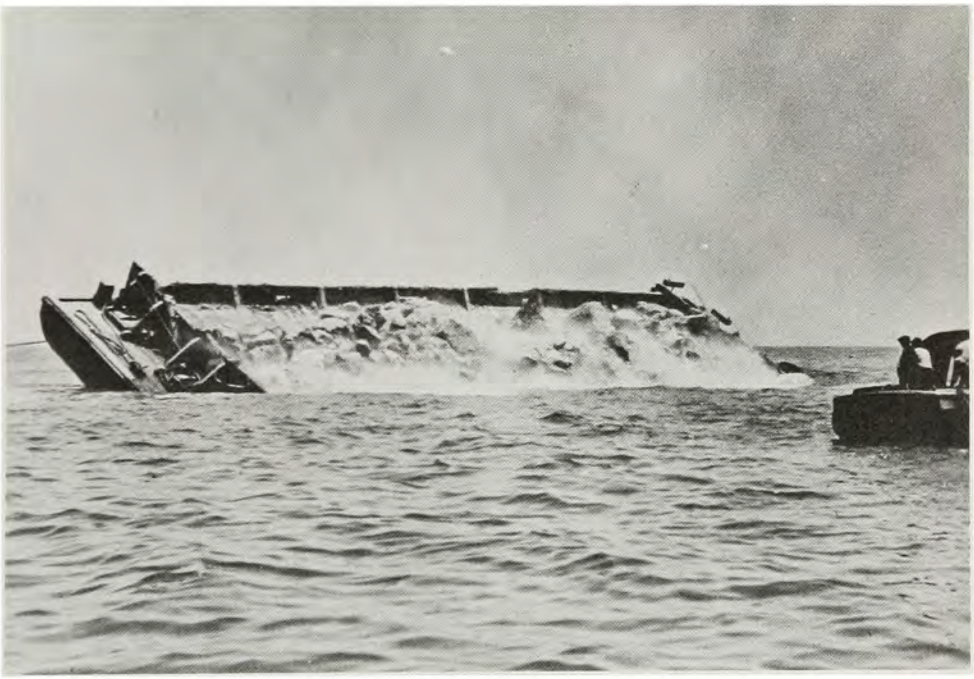
This is a view of operations and the face in the quarry near Avalon on Catalina Island, the source of stone for the breakwater, October 26, 1932.

World War II demonstrated the necessity for further development of the harbor to provide facilities for loading and unloading of troop ships and vessels handling war materiel. During both World Wars I and II the West Basin was used extensively by the shipbuilding industry.

In the 1950's and 1960's the district engineers under instructions from Congress concentrated on projects which led to the expansion and deepening of all major harbors. Within the Los Angeles Harbor extensive anchorage areas and an entrance channel 1,000 feet wide and 40 feet deep to the outer harbor and 35 feet deep in the inner harbor have been dredged. The Cerritos Channel which connects the two inner harbors was widened to 400 feet with a depth of 35 feet. Similar dredging enlarged the Long Beach Harbor to 35 feet in depth. Terminal planning and construction by the local agencies controlling the ports has boomed.



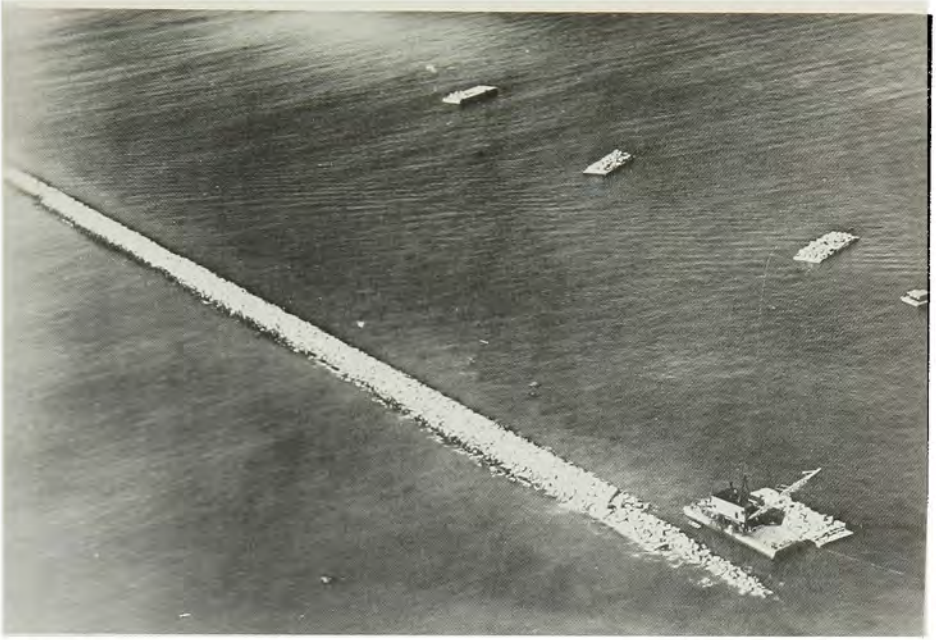
A clamshell dredge working in the outer harbor provides material for the core of the detached breakwater.



A barge load of "B" rock slides from the barge onto the breakwater mound.

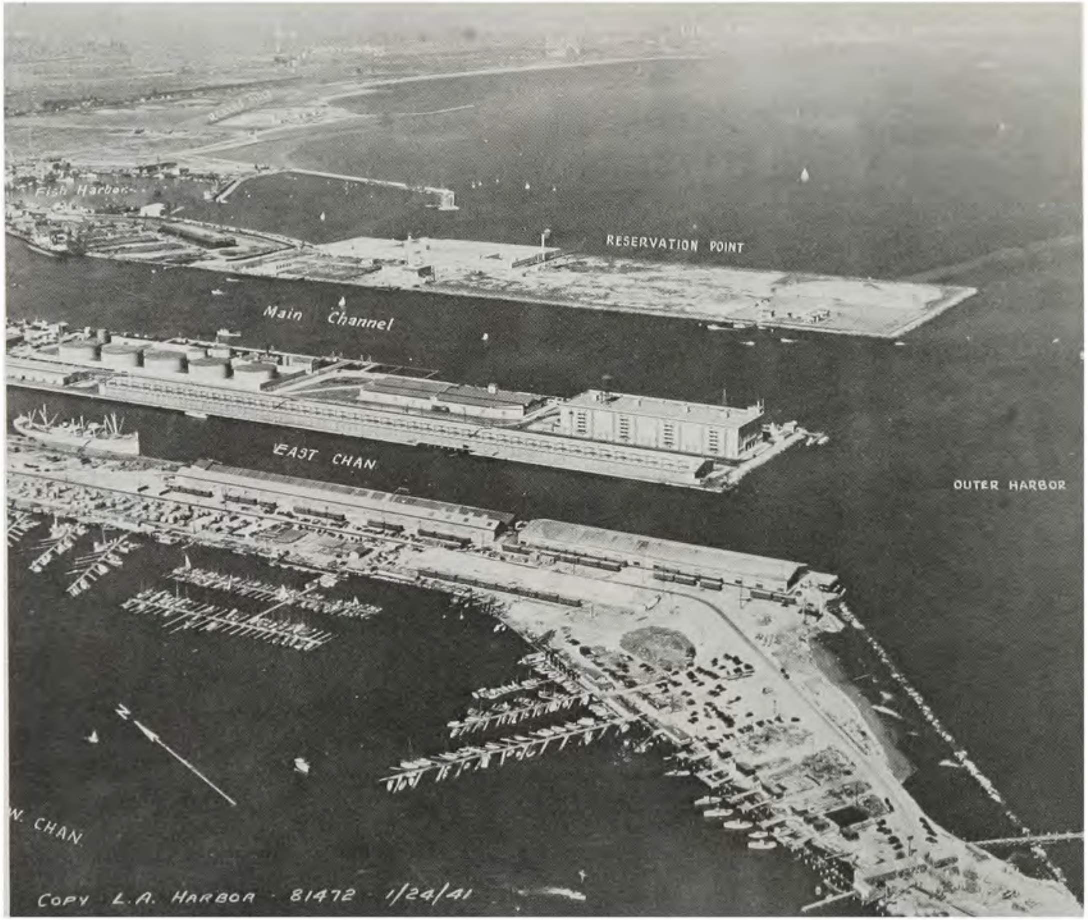
A crane in the quarry near Riverside hoists a piece of "A" rock from a truck to a flatcar on the railroad.

International crises and technological changes dictated further modifications to the harbors. The closure of the Suez Canal stimulated spectacular break-throughs in the design of tankers and other bulk carriers. Big ship technology offered substantial economies in the movement of cargoes and probably made the Suez Canal obsolescent. During World War II, the world marvelled at a supertanker which carried 17,000 tons of petroleum. Now 200,000 ton carriers are routine with 500,000 tonners on the design boards. Ship designers also have produced 100,000 ton ore carriers. With their usual foresight both the harbor authorities in Los Angeles and Long Beach dredged their entrance channels to the depths of 52 feet to special wharves to provide berths for supertankers in particular.



This close-up view of the detached breakwater shows a derrick barge in position to place the "A" stone on the top of the breakwater and three barges waiting to be unloaded in the upper right.

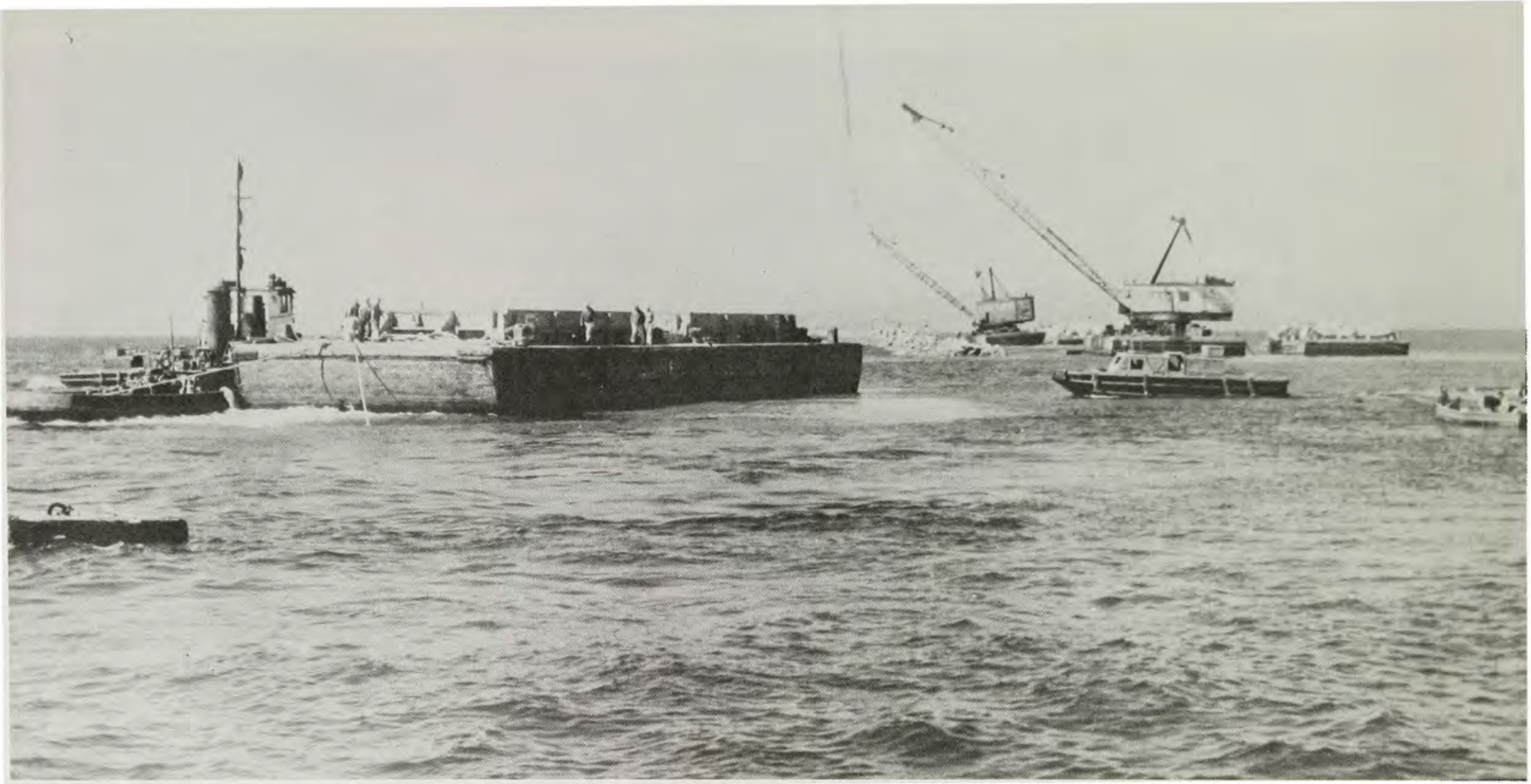
A view of the Los Angeles-Long Beach Harbors and the completed breakwater. At anchor in the area protected by the improvement lies part of the United States fleet (1938).



Los Angeles Harbor, January 1941.

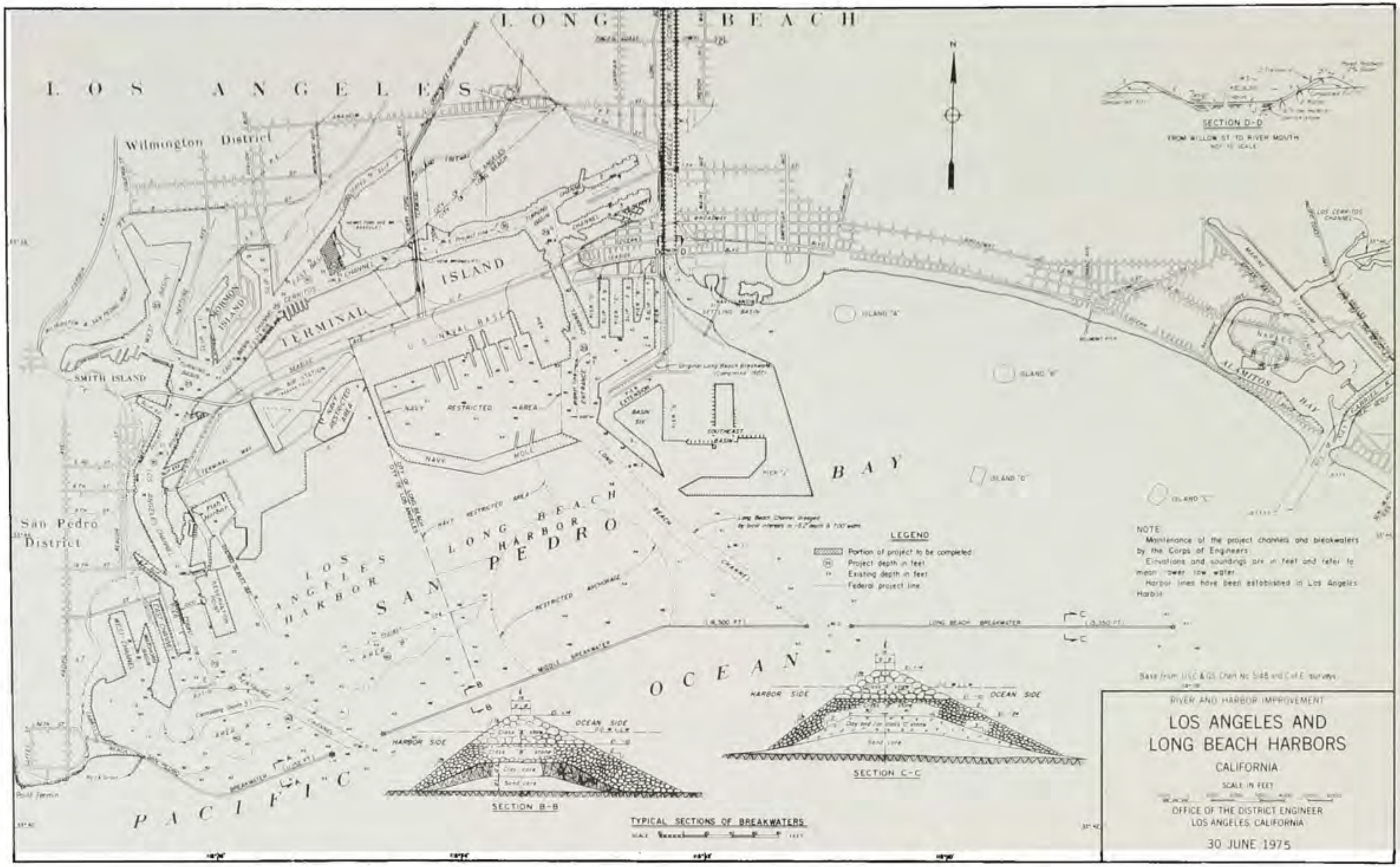
Aerial view showing the connected harbors of Los Angeles (left) and Long Beach (right) and about one half of the outer breakwater chain protecting the harbors (1946).

Los Angeles Harbor, 1946.



Detached breakwater, Los Angeles-Long Beach Harbors. Work in progress on breakwater construction; in distance the derricks are placing "A" stone on the breakwater; barge of "B" stone has just been dumped in the foreground (1947). Work was completed in 1949.

Aerial of Los Angeles-Long Beach Harbors (c. 1965).

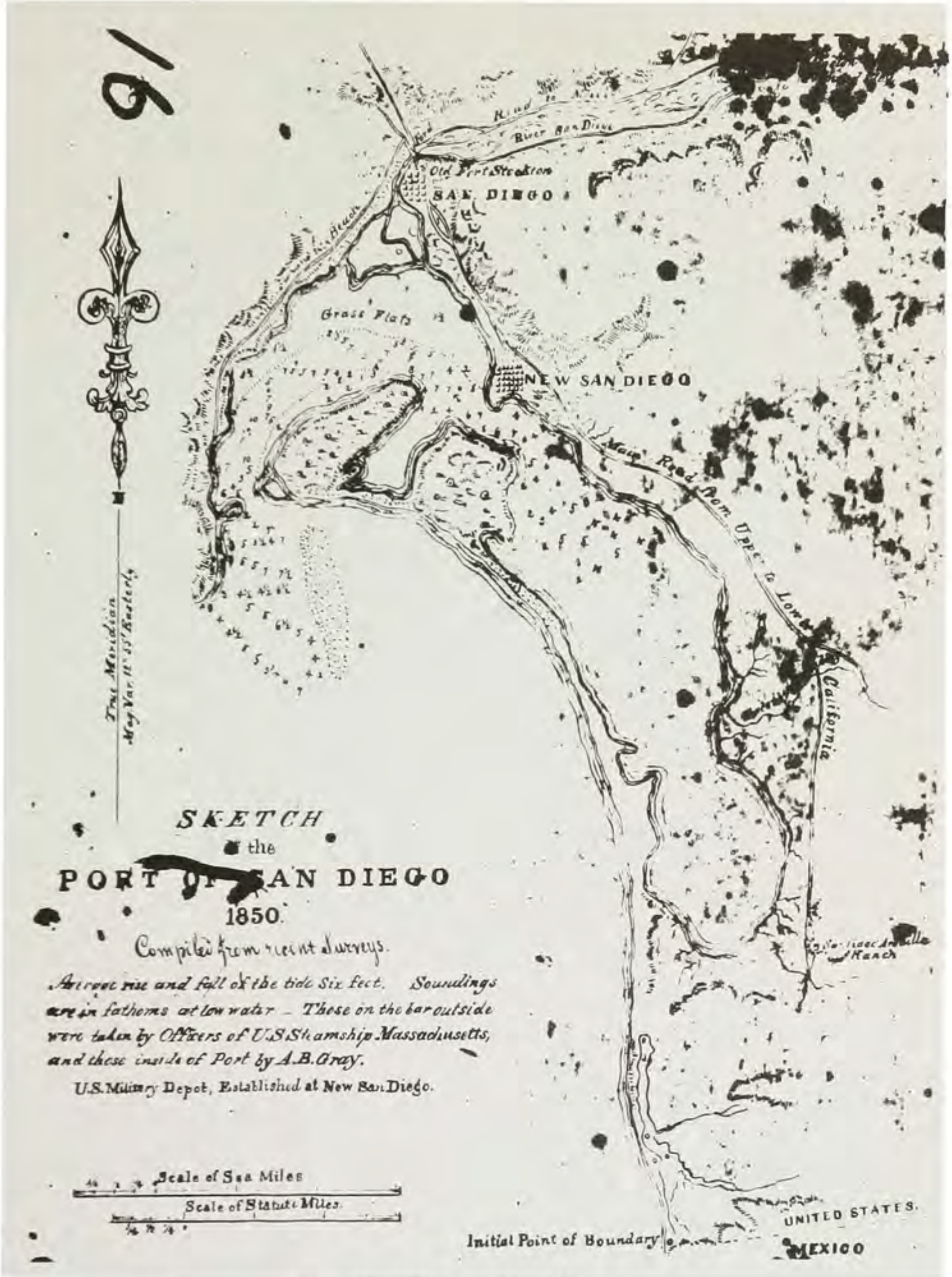


Schematic map of Los Angeles and Long Beach Harbors (1975).

Having the only large natural harbor in southern California, San Diego strove to become the gateway to the region. For many years San Diegans were frustrated. Isolated by high, steep mountains and the desert on the east and Baja California on the south, without an adequate water supply, and unable to obtain a railroad connection to eastern and northern regions of the United States, San Diego and its magnificent harbor failed to reach their potential until well into the 20th century. San Diego Bay did receive two early distinctions. The first river and harbor work in California was authorized for the Corps of Engineers in 1852. Instead of depositing silt into False Bay (Mission Bay), the San Diego River cast a new channel pouring its silt into the harbor proper which generated fears that an excellent harbor might be destroyed. In 1853 Lieutenant George Horatio Derby, humorist as well as engineer, arrived, hired 60 Indians and built a make-shift levee diverting the river into the old channel so that it discharged once again into False Bay. As Derby had predicted, the levee disappeared under the impact of floodwaters within two years, as appropriations for reinforcing works were not made. As a humorist, Derby with his stories and sketches made a more memorable contribution to California than to flood control. Finally in 1875 after numerous investigations by the Army Engineers, Congress appropriated sufficient funds which First Lieutenant J. H. Weeden used to build a substantial levee across the old river channel near its entrance into the harbor and a new channel was cut conducting the river into False Bay.

Even natural harbors require considerable modifications. To prevent the encroachment of man-made facilities like wharves into the channels, Army engineers established harbor lines. Authorized in 1888, a Board of Engineer Officers – Colonel George H. Mendell, Major William H. H. Benyaurd, Major William H. Heuer, all of whom played

San Diego from the Bay as in 1850



Sketch of Port of San Diego.

vital roles in the development of southern California – commenced that task in 1890 which allowed the proper placement of terminal facilities, without infringing on channels. Vagaries of ocean currents, advances in ship technology, and new defense obligations of the United States in the Pacific demanded improvements which the Army Engineers provided under the direction of Congress. In 1890 to eliminate shoaling in the entrance channel, to secure depths of 24 and 26 feet in that channel, and to widen certain portions, Congress authorized and appropriated funds to accomplish these objectives. To increase the strength of the tidal currents to produce a scouring effect upon the outer bar and deepen the channel, the engineers constructed Zuniga jetty, about 7,500 feet in length.

Failure to emerge as a transcontinental railroad terminus temporarily dampened the hopes of San Diegans to convert their natural roadstead into a major commercial harbor for the Pacific trade. Ultimately, military requirements stimulated by the Spanish-American War, the acquisition of island possessions in the Pacific and major wars of the 20th century were largely responsible for the character and extent of the harbor improvements at San Diego. Furthermore, as stated in the *Annual Report of the Chief of Engineers for 1913,* the completion of the Panama Canal was a major factor for improving not only the San Diego Harbor but also all other Pacific Coast harbors.

Forty years after the first rivers and harbors project in San Diego, authorization came for dredging the harbor to depths from 24 to 28 feet. By 1910 the engineers were ordered to dredge 30 feet. In 1961 under LAD direction the U.S. Hopper Dredge *Harding* dredged the entrance channel to 42 feet, with various anchorages and interior channels of 26, 30, and 35 foot depths, with additional improvements authorized in 1968. Main impetus was furnished by the need to accommodate large aircraft carriers. Local authorities cooperated eagerly as demonstrated by their constructing ample harbor facilities for shipping needs. Today an authorized study is investigating a long-pending proposal to cut a second entrance into San Diego Bay.

Thus has LAD turned into a reality what appeared to be the fanciful, wishful dreams of the San Diego Chamber of Commerce which in 1901 issued a sketch of the bay with 174 piers, all connected to railroads and to sea lanes of the Pacific. Since 1945 the amount of commerce handled by the Port of San Diego has increased to the point where the existence of San Diego is no longer dependent solely on the United States Navy.

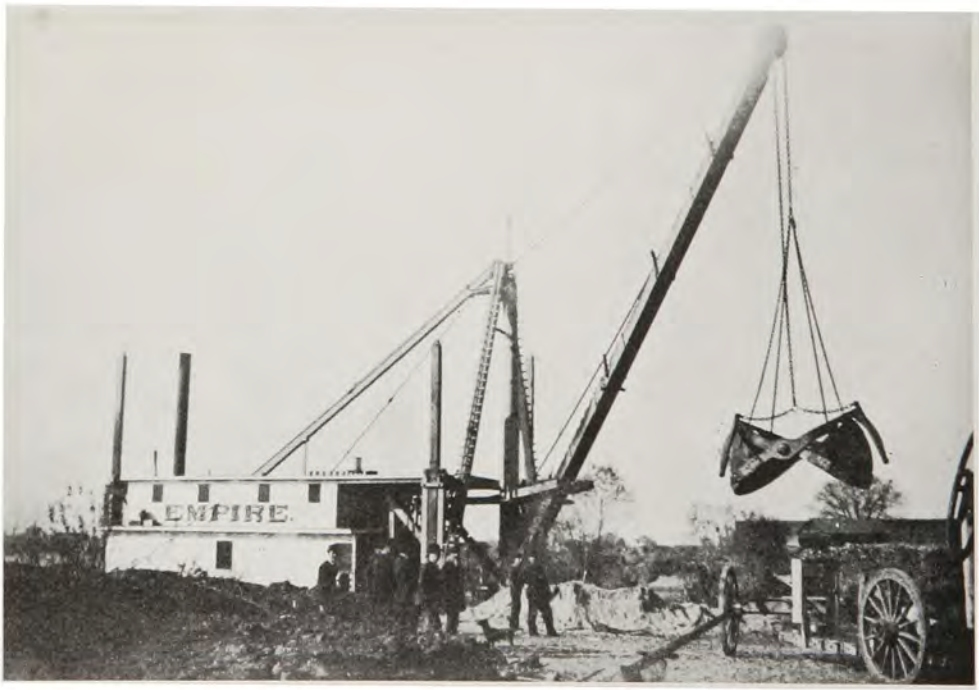
The development of another major harbor, Port Hueneme, 65 miles northwest of Los Angeles Harbor, is under consideration by LAD. What once appeared as another nebulous dream of typical Californians who

In September of 1893 Silas R. Smith, under contract by the Corps of Engineers, began work on the Zuniga jetty. The following photographs record his effort.

In this view an office building rests on a Coronado Island sand spit at the entrance to San Diego Harbor. Ballast Point Light House and other building are in the left background. Contractor Silas R. Smith has a bunkhouse under construction in the middle background and a scale pit is in front of the house (September 27, 1893).

The quarry of S. R. Smith for jetty rock (September 27, 1893).

Another view of the quarry at Sweetwater with Sweetwater Dam in the left background. (Photo by E. P. Gray, 1895)



Equipment used on the job.

Building mat for end of extension of shore revetment, San Diego jetty (Zuniga), September 1895.

San Diego jetty, from end of old work, Bent 158, showing spur and breaker to west of line of jetty, October, 1895.

Dredge *Harding* in San Diego main channel, April 1961.

visualized a swamp as a harbor is on the brink of realization. By 1940 courage and determination brought into being a harbor at Port Hueneme, but one with rather limited facilities. The harbor was under private auspices since the district engineer had properly concluded in 1936 that there was no justification for a deepdraft, commercial harbor at Port Hueneme.

However, the circumstance of World War II changed the picture and involved the Federal Government, for the United States Navy required a completely Navy-controlled facility on the west coast, particularly as a center for the Seebees. Port Hueneme was selected. Under Navy auspices harbor and dock-side facilities were enlarged considerably to provide nine capital ship berths and several slips for small landing type vessels. Significantly, more dry cargo for the needs of the Navy was shipped from Port Hueneme than from any other port in the United States.

After World War II with a drastic decline in military requirements the Navy permitted the Oxnard Harbor District to re-acquire the port which, while suitable for the Navy, still had only limited facilities available for commerce.

Through their representatives in Congress the Harbor Commissioners persuaded Congress in the 1968 River and Harbor Act to have the existing Harbor adopted as a Federal project. LAD is preparing a report for the modernization and expansion of the harbor. Since LAD insisted on a hydraulic study of potential surge action which would delay the project, the district agreed to a compromise whereby the Harbor Commissioners could proceed with a modified project for expansion.

Steadily increasing shipping demands place pressure on all agencies to meet these demands and revise the master plans for all southern California ports accordingly. These augmented needs of commerce dictate construction of terminals that will exhaust rapidly the amount of land fronting on water navigable by deepdraft vessels.

In anticipation, Congress authorized LAD to cooperate with the respective port authorities in investigations whose ultimate objectives would expand and deepen the four deepwater ports of southern California. LAD completed a study of San Diego Harbor recommending the deepening and expanding of navigation channels in the harbor to enable the harbor district to construct major terminals. While agreeing to the requests of the local interests for similar work at Port Hueneme, the District Engineer temporarily delayed work on the improvement until a hydraulic study of potential surge action could be performed at Vicksburg, Mississippi.

A long range study of the needs of the Ports of Los Angeles and Long Beach commenced in 1965. As usual, considerable controversy, of a healthy type, has ensued. Present plans by port authorities call for filling in about half the open water enclosed by the outer breakwaters in San Pedro Bay, which would result in a drastic loss in recreational facilities. Another plan would deepen the channels leading to existing terminals and provide new channels which would allow terminal development seaward of Terminal Island. Among other suggestions is one to preserve the existing open waters by utilizing the seas immediately outside the existing harbor limits of San Pedro Bay. Essentially, every plan proposes to enlarge the terminal capacities of the twin harbors.

Before determination of an effective solution, studies involving complicated analyses with hydraulic models to resolve enviromental and ecological issues are necessary. As William J. Herron, Jr., retired Chief of Coastal Engineering, neatly phrased it, "The days of 'seat-of-the-pants' engineering are over." In a speech, Neil E. Parker, formerly a Project Manager in Coastal Engineering, and now in Washington, D.C., reiterated that problems of deepening channels, building breakwaters, limiting costs to actual dredging or rock placement were resolved easily in the past. Today engineers must consider, in addition, such knotty problems as saltwater intrusion, pollution of aquifers, adverse effects on fish and wildlife, impact on natural features like tidal estuaries, recreational matters, flood damage prevention, and beach erosion. Shipping considerations are important, but are still subordinate to the overall needs and welfare of the people.

With the revolution in shipping involving supertankers for carrying petroleum and large container ships, sophisticated harbor planning is obligatory. Containerization exacts radical changes in traditional land-water ratios. To operate at an economically efficient level, the new monsters of the sea need to unload and load within a 24-hour period. With its past record in assisting port agencies in converting southern California mudflats into leading world port complexes, LAD will have no more than the usual problems in coping with the task of continual updating of major west coast harbors.

Port of San Diego, 1961.

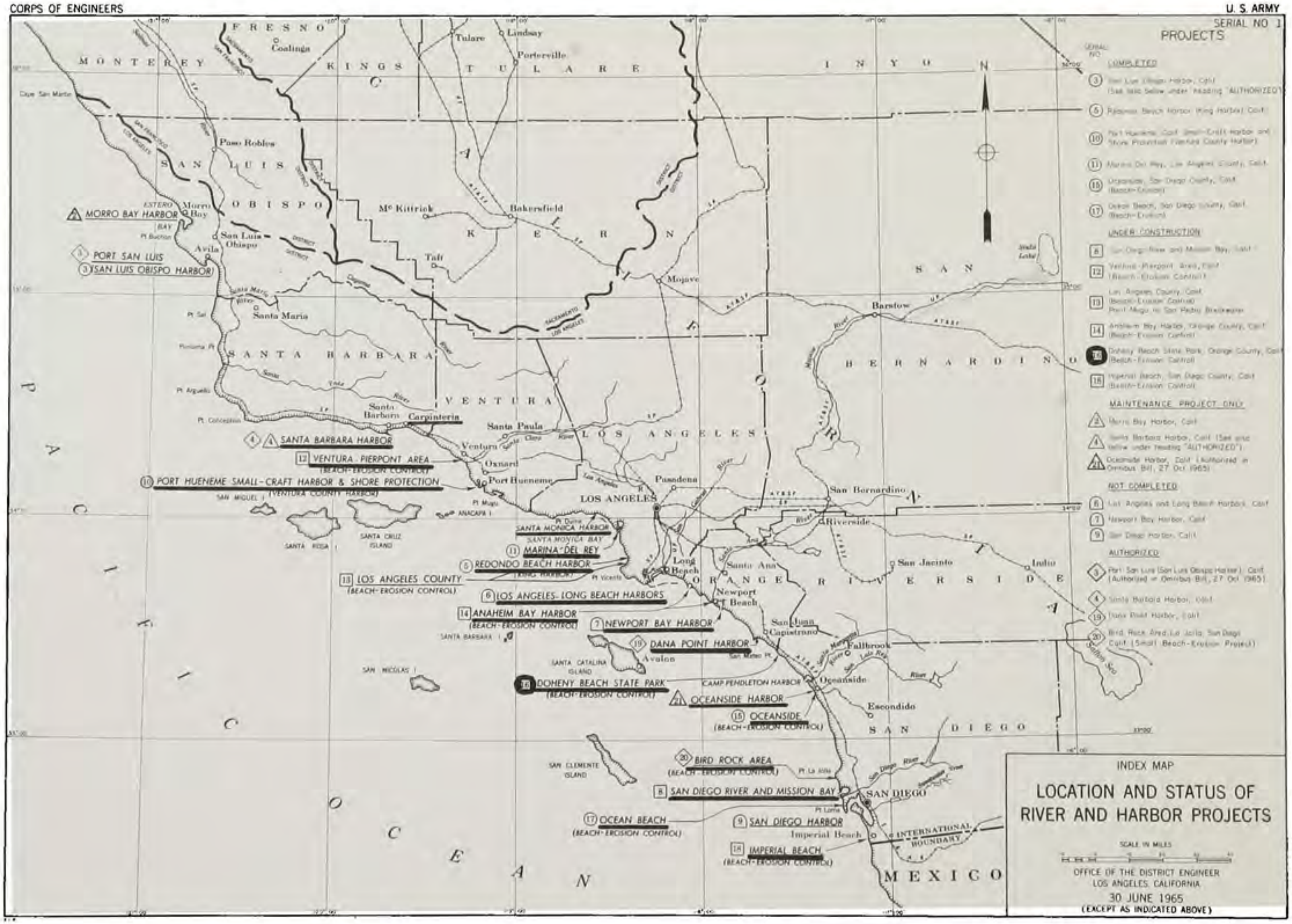
Port of Long Beach.

Port of Los Angeles.

CHAPTER III

FROM MAJOR HARBORS TO SMALL CRAFT HARBORS AND FACILITIES

Perhaps no better illustration of change in the mission of the Corps of Engineers and its adaptability to changes in the American society exists than the recognition of the importance of recreational navigation by the United States and the Corps. Originally, the underlying philosophy in this area for LAD found its best expression in a survey report on Alamitos Bay (February 29, 1928), by D. E. Hughes to Major C. P. Gross, District Engineer, "that our department is not concerned with pleasure craft anyway; for though they may navigate as far as Mexico, *commerce* cannot attach to them in any sense used by the framers of the Constitution." But the American people have always adapted their Constitution to their varying needs. Paradoxically both the growing affluence of the United States and the impact of the depression of the 1930's brought about the broadening of the term "commerce" to include pleasure craft. The reinterpretation was made by Congress, an institution which generally reflects changes in thinking and attitudes within the American society. Congress on February 10, 1932 in an amendment to the basic River and Harbor Act of 1902 defined "commerce" to "include the use of waterways by seasonal passenger craft, yachts, house boats, fishing boats, motor boats and other similar craft whether or not operated for hire." By this action Congress also expanded the mission of the Corps of Engineers. In 1933 a second action of Congress which indirectly influenced the development of small boat harbors was the passage of the National Industrial Recovery Act, the purpose of which was to relieve unemployment by stimulating economic activity. Thus Federal participation in the construction of small craft harbors could be authorized as a means of resolving the severe economic depression. In southern California these two acts quickly led to proposals for such harbors, particularly by communities like Newport Beach which previously had been frustrated in efforts to obtain Federal assistance for development of a commercial harbor. The proposal by Newport Beach led to the construction of an excellent harbor, but the other proposals were deferred, for the policy of the Corps of Engineers was to approach such matters with considerable caution until sufficient data concerning all aspects of small boat navigation were accumulated. For southern California LAD undertook this assignment under the direction of Major Theodore Wyman, Jr., District Engineer, and completed the task under his successor, Lieutenant Colonel Edwin C. Kelton, who issued in 1940 a booklet, *Small Boat Navigation, Southern California.* Data were obtained from previous harbor reports of LAD, from the records of the United States


CORPS OF ENGINEERS
U. S. ARMY
SERIAL NO 1
PROJECTS
COMPLETED
UNDER CONSTRUCTION
MAINTENANCE PROJECT ONLY
NOT COMPLETED
Newport Bay Harbor, Calif
AUTHORIZED
MORRO BAY HARBOR
PORT SAN LUIS
SAN LUIS OBISPO HARBOR
SANTA BARBARA HARBOR
VENTURA PIERPONT AREA
PORT HUENEME SMALL-CRAFT HARBOR & SHORE PROTECTION
SANTA MONICA HARBOR
MARINA DEL REY
REDONDO BEACH HARBOR
LOS ANGELES COUNTY
(BEACH-EROSION CONTROL)
LOS ANGELES-LONG BEACH HARBORS
ANAHEIM BAY HARBOR
(BEACH-EROSION CONTROL)
NEWPORT BAY HARBOR
DANA POINT HARBOR
DOHENY BEACH STATE PARK
(BEACH-EROSION CONTROL)
CAMP PENDLETON HARBOR
OCEANSIDE HARBOR
OCEANSIDE
(BEACH-EROSION CONTROL)
BIRD ROCK AREA
(BEACH-EROSION CONTROL)
SAN DIEGO RIVER AND MISSION BAY
OCEAN BEACH
(BEACH-EROSION CONTROL)
SAN DIEGO HARBOR
IMPERIAL BEACH
(BEACH-EROSION CONTROL)
PACIFIC OCEAN
MEXICO
INTERNATIONAL BOUNDARY
LOS ANGELES
SAN DIEGO
INDEX MAP
LOCATION AND STATUS OF
RIVER AND HARBOR PROJECTS
SCALE IN MILES
OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA
30 JUNE 1965
(EXCEPT AS INDICATED ABOVE)

Collector of Customs, the County Assessors, and additional data were added through a questionnaire sent to interested parties. Based upon this information, a proper estimate was made of the amount and classification of recreational navigation facilities required in southern California and of possible future benefits.

The findings of this 1940 study of small boat navigation, while refined by later studies of many agencies, accurately protrayed what had to be done. Among the more significant aspects were the following: although the very favorable weather conditions in southern California provided all-year activity for boating, that condition was offset by the rugged coast and lack of protected harbors to provide safe anchorage for small boats. To meet these needs, investigations and surveys were necessary to determine the costs of works like breakwaters and dredging existing bays and inlets, the extent of contributions by local interests, and the relation of need to probable cost. Since the major harbors of Los Angeles, Long Beach and San Diego were not designed for recreational boating, there was the additional danger that the continued growth of commerce would eventually reduce and probably eliminate pleasure craft from commercial harbors, a situation which produced additional pressure for specialized harbors for small craft.

The report evaluated the potential facilities for small craft in the existing harbors and sites of future harbors at San Diego Harbor, Mission Bay, Newport Harbor, Anaheim Bay, Alamitos Bay, Los Angeles and Long Beach Harbors, Redondo Beach, Playa del Rey, Santa Monica, Port Hueneme, Santa Barbara, Port San Luis, Morro Bay, and Santa Catalina Island. Benefits, tangible and intangible, proved to be more than sufficient justification for more harbors.

A major difficulty for LAD and other components of the Corps was the development of basic criteria to determine the monetary benefits to be expected and equitable allocation of the costs of small boat harbors between Federal and non-Federal agencies.

Prior to 1950, in the small boat harbor and channel reports, each District Engineer of LAD utilized his own judgment as to the proper amount of local cooperation to be required. This variety of procedures caused an appearance of inconsistency. To resolve this difficulty, the Chief of Engineers in February 1950, with minor modification in March 1951, arrived at a uniform method for evaluating and allocating the expected benefits and costs for small boat harbors. In general the policy required local interests to pay 50 percent of the average annual cost of such installations, exclusive of self-liquidating features which were omitted in the computations.

Obviously World War II turned the attention of LAD away from Federal participation in non-defense activities, but after the war the needs of small boat navigation occupied the attention of the District. An additional spur was the concern about shifting a war-oriented economy to more normal economic activities. Public works projects were looked upon as the best means of alleviating the stress and strain of the transition. As the Federal agency with the greatest experience in the construction of navigation facilities, the Army Corps of Engineers, most of whose previous projects were for deep-draft vessels, was authorized to investigate the feasibility of similar facilities for shallow-draft vessels.

Thus Congress authorized LAD in March 1945 to make a preliminary examination and survey of the coast of southern California with a view to establishing harbors for light-draft vessels. Under the direction of Colonels R. C. Hunter and A. T. W. Moore, LAD prepared a comprehensive, far-reaching study for the orderly development of small boat harbors for southern California, ranging from Cape San Martin to the Mexican border, a cruising distance of about 420 miles. Although the State of California had a long range program for the acquisition and improvement of public beach frontages along the entire coastline, no program was in existence for the development of small craft harbors, a fact which indicated the significance and need of the LAD study.

The report easily established the demand for such a program. Two major assets of tremendous potential wealth to the State of California and the country, fishing and recreation, for which the coast of southern California was well endowed, were in need of exploitation. The great fishing banks off this coast were relatively untapped, primarily because few safe harbors were available as home ports for commercial and sports fishermen, while those available were spaced too far apart for the operation of safe, economical and continuous fishing operations. Faced with a population explosion, particularly in the coastal counties, southern California also required recreational opportunities which the development of recreational boating would assist in achieving. As economic development of the area kept pace with the growth of population, people had leisure time available and the economic means to exploit the recreational assets of southern California if sufficient safe harbors were provided.

With its usual democratic procedure LAD held a public hearing to offer interested parties the opportunity to present plans of proposed harbors for light-draft vessels. It also made certain that all parties whose interests might be affected by the desired improvements were invited to be present or to be represented in order to express their views.

After an investigation of all 23 sites for small craft harbors proposed by local interests, LAD recommended further studies of 10. If constructed, this group, added to those harbors already established or authorized, would provide a chain of harbors at intervals not exceeding 45 miles along the coast of southern California as bases of operation and ports of refuge for fishing and recreational boats. Further studies were justified for Cambria, Avila (Port San Luis), Lompoc Landing, Coxo Anchorage, Pierpont Bay, Port Hueneme, Malibu Creek, Agua Hedionda Lagoon, Roseville, and National City-Chula Vista. With one modification – a survey report for the whole San Simeon Bay-Cambria area rather than Cambria alone – the Division Engineer concurred. At that time, further investigations were deemed not warranted for harbor sites located at Arroyo de la Cruz, San Simeon Bay, Morro Bay Harbor, Santa Barbara Islands, Point Dume, Portugese Bend, Anaheim Bay Harbor, Offshore Islands, Camp Pendleton Harbor, Buena Vista Lagoon, Batiquitos Lagoon, San Dieguito River and Tia Juana River.

In addition LAD gave, or had given, separate consideration to small boat facilities at Santa Barbara, Santa Monica, Playa del Rey, Redondo Beach, Los Angeles and Long Beach Harbors, Alamitos Bay, Upper Newport Bay, San Diego Harbor (including Glorietta Bay), and Mission Bay, with the latter the subject of a definite project report. At the same time the San Francisco District produced a similar investigation of the coast of northern California, with the net result of a more than adequate plan for the development of small craft harbors in California. That report of 1949 also resulted in the adoption of a 35 nautical mile spacing for harbors of refuge.

To date the proposed plan has not materialized, not for lack of planning but primarily for lack of funding, particularly by local and State agencies. By 1950 pressures for facilities to serve boats became more urgent as the popularity of boating in California, as in the rest of the nation, accelerated appreciably. To meet this demand, the Legislature of the State of California created the State Division of Small Craft Harbors and the Small Craft Harbors Commission in 1957. With the assistance of various agencies at differing levels of government, including the Corps of Engineers and consulting engineers, the above State agencies produced the California Boating Plan of 1964 which called for the coordination of the efforts of public agencies of all levels and of private developers to provide adequate facilities for the rapidly growing small boat fleet, both commercial and pleasure. In 1966 the Wells Fargo Bank reported that California had 345,000 pleasure craft valued at more than $400 million and predicted that by 1975 there would be 560,000 pleasure craft, of which 40 percent would be owned by people residing along the Pacific Coast south of Ventura County. This phenomenal expansion in boat ownership more than substantiated the predictions in

the 1947 report by LAD that two of the major industries of southern California were fishing and recreation.

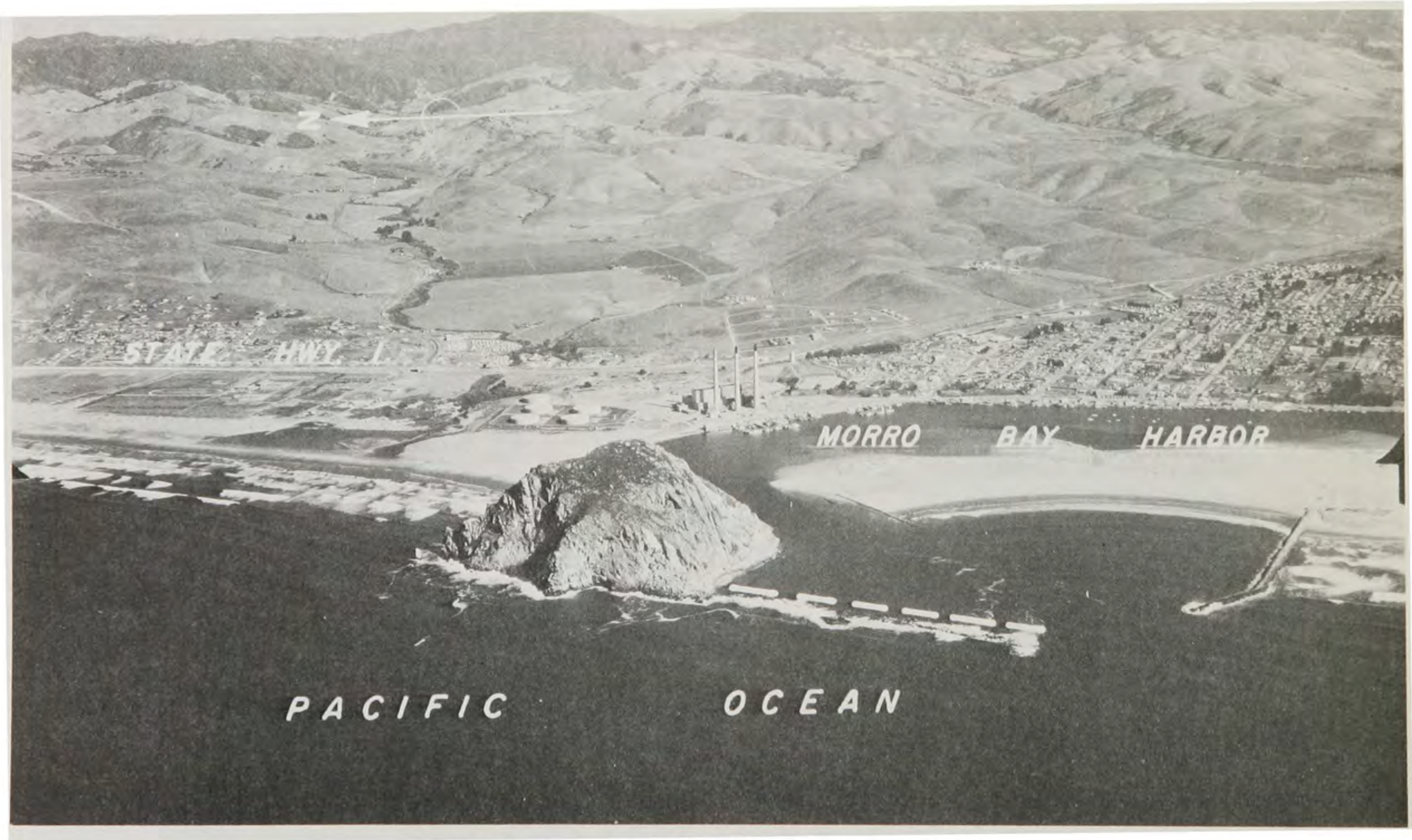
A review of the small craft harbors, existent and authorized, within the Los Angeles District will illustrate the various ways in which the Federal Government contributes and has contributed to the construction or maintenance of small craft harbors. As in all phases of its work the Corps of Engineers worked closely with the State of California and the coastal communities in the execution of what is now a master development plan. Economic conditions and the priority of projects govern the actual appropriation of Federal funds for the initiation of construction of recommended projects. Recessions, inflation, and international emergencies like Korea and Vietnam inhibit the efforts of LAD and the other agencies involved. In spite of these factors considerable progress had been made toward the development of a chain of recreational harbors in southern California.

Nothing has transpired at Arroyo de la Cruz, as the San Simeon-Cambria site was deemed sufficient to meet the needs of that area. On the latter a survey report is authorized, with the major objective of determining whether there is a need for a harbor of refuge.

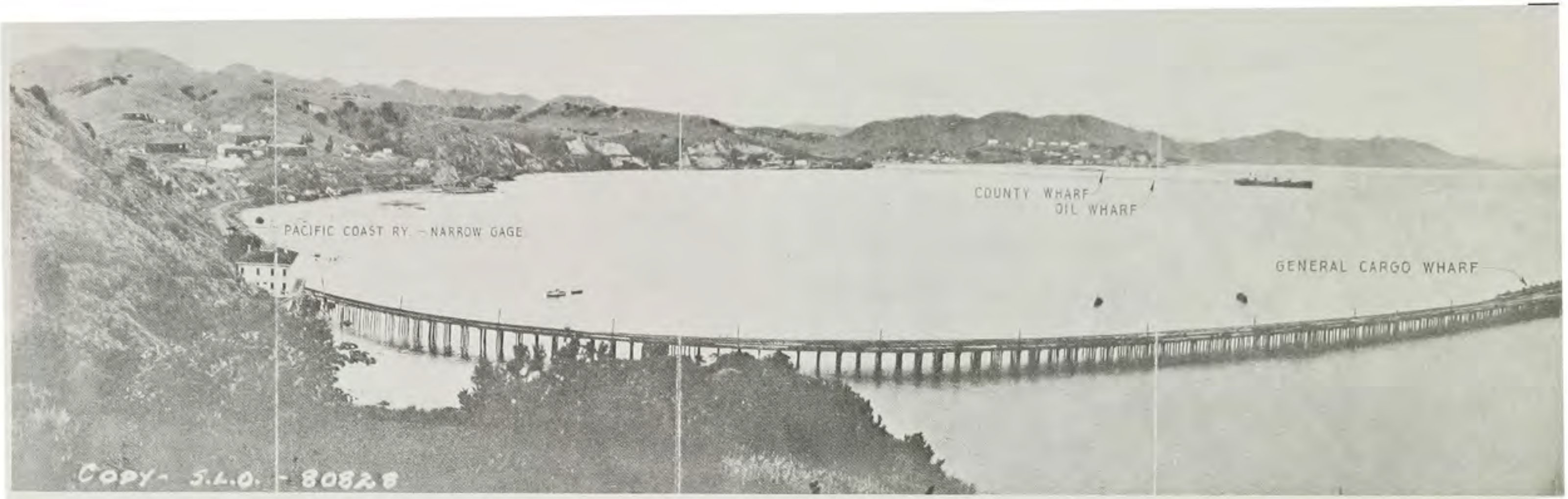
At Morro Bay, in San Luis Obispo County, local interests in 1940 obtained a survey report from LAD. However, improvement to the harbor was initiated in 1942 as a national defense project at the request of the Department of the Navy, but still under the supervision of LAD. This natural bay of considerable environmental beauty was improved for navigation by the construction of two random stone jetties, an entrance channel, two harbor channels, and a quarry-waste revetment for the entire waterfront. By 1946 the harbor project was complete. After World War II the Navy released the harbor to the community, but Congress authorized Federal maintenance of the structures and navigational channels. Maintenance of the jetties and channels proved to be a problem. Studies by LAD and the local government are underway to determine the feasibility of modification to enlarge the capacity of the harbor for additional small craft as well as to solve the existent problems. The scenic harbor with Morro Rock as the attraction served recreational and commercial craft adequately for years, but it now requires further development to meet the new demands.

Port San Luis (San Luis Obispo Harbor) was originally known in its early history as Port Harford and as a rendezvous for pirates. Harbor improvements were authorized in 1888, 1893, and 1898 and completed in 1913, but only limited facilities resulted. At the request of local interests, LAD obtained authorization from Congress in 1965 for

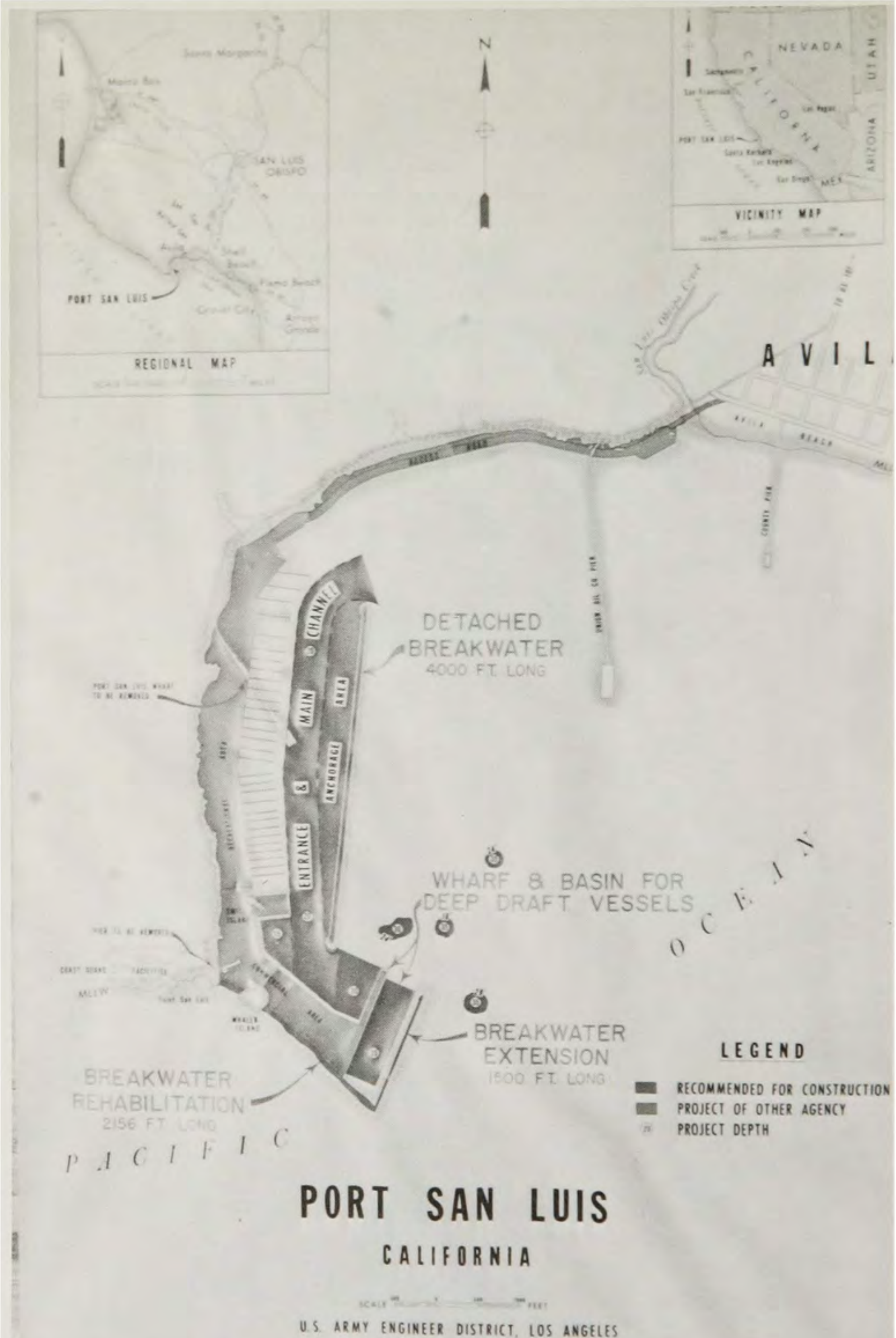
Aerial view of Morro Bay prior to harbor improvement, 1941.



Rehabilitation of north breakwater in progress in 1962.



Panorama of San Luis Obispo Harbor (San Luis) in 1936. (From Port Series No. 13, Revised, 1936, Corps of Engineers, U.S. Army.)



Plan proposed for improvement
of San Luis Harbor, 1962.

preconstruction planning with the ultimate objective of providing ample facilities for small craft. The planned additional breakwater would convert the harbor to an all-weather one.

Besides being the center of controversy over oil drilling, Santa Barbara is an important small craft harbor. Between 1873 and 1934 six unfavorable reports were made by the Corps with regard to local efforts to obtain a deepwater harbor at Santa Barbara as justification had to be based upon commercial prospects.

However, in 1928 the city, with the financial assistance of an ardent local yachtsman, did construct a partially protected harbor for small boats. Unfortunately this breakwater interrupted the normal littoral movement of sand with disastrous results, for extensive shoaling occurred in the harbor. At about this time, felicitously, Congress expanded the authority of the Corps to include recreational boating as a consideration so that LAD came to the rescue.

Authorization in 1935 provided for maintenance by dredging to the depths which existed in 1934. Authorization in 1945 allowed maintenance through utilization of a fixed sand-intercepting plant which would be operated by local interests with reimbursement by the Federal Government up to $30,000 annually toward costs of dredging. Propitiously, the dredged material would be deposited on beaches downcoast, thus compensating for the continuous beach erosion which plagued the area. In 1953 Santa Barbara received permission from the Federal Government to substitute a movable dredge for the fixed plant (which was never built).

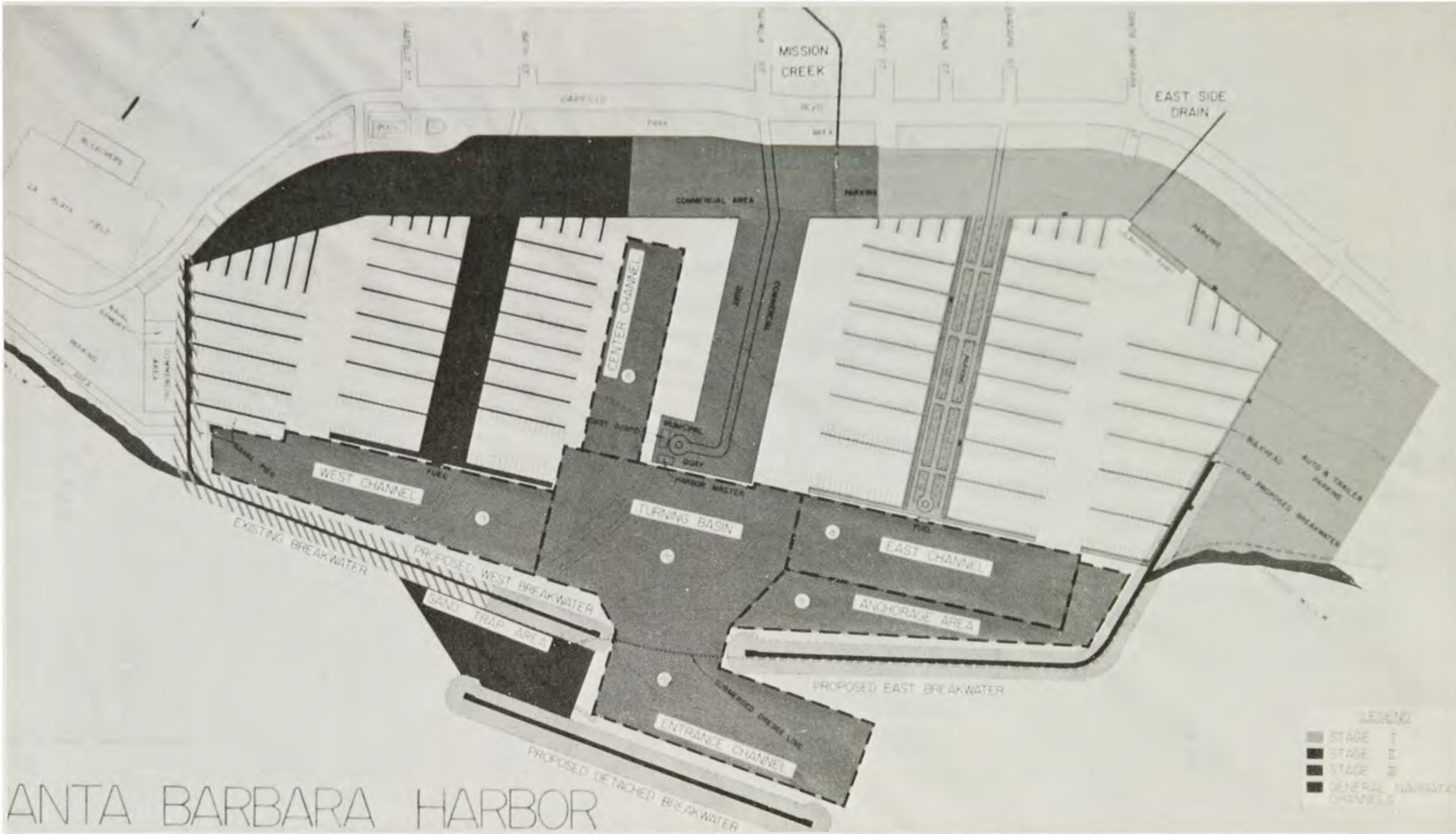
Overcrowding and other problems produced a request for a preliminary study involving consideration of three harbor sites – Goleta, Carpenteria, or expansion of the existing Santa Barbara Harbor for future development. Construction at Goleta and Carpenteria was not justified, but in 1962 authorization to triple the size of the Santa Barbara Harbor was approved. In cooperation with the local government and the Department of Harbors and Watercraft, the major agency of the State of California in the coordination of efforts for the development of small craft harbors, Coastal Engineering of LAD undertook preconstruction planning.

In 1964 Colonel E. G. Peacock, District Engineer, stated that the entrance design was unique, so far as he knew, for small craft harbors. The detached breakwater as designed will serve several purposes: to shelter the entrance; to eliminate wave action inside the harbor; and to serve as a sand trap to concentrate the littoral sand movement and permit year-round operation of a small pipeline dredge which would

Santa Barbara Harbor dredging by engineers to maintain depths, Dec. 23, 1934.

Crowded conditions and constant buildup of sand in the Santa Barbara Harbor requiring constant dredging (shown in the middle background) led to planning a project to eliminate those conditions.

Sandspit buildup in the entrance to Santa Barbara Harbor creates navigational hazards.



Proposed improvement for the Santa Barbara Harbor requires local approval.

maintain the harbor entrance depth and bypass the sand to the downcoast beaches. In order to obtain a properly designed harbor, a model study of the proposed improvements at Santa Barbara will be made at the Waterways Experiment Station at Vicksburg, Mississippi – an example of the thoroughness and sophistication of new engineering procedures. As Colonel Peacock told the Santa Barbarans: "We, the Corps of Engineers, are not a using agency. This will be your harbor not ours, and we are at your service to build you the kind of harbor *you* want – when you want it. Mr. Herron or I will be available at anytime to answer your questions and assist you in any manner, but the decisions are yours as to *when* and *how you* want this project." Thus the project still awaits a decision by Santa Barbara officials.

On the coast of Ventura County three small boat harbors are developed or being developed which not only provide harbors of refuge but also accommodate the needs of the growing numbers of small-boat owners in the county. This growth resulted from the population spreading out of metropolitan Los Angeles onto the Ventura plains.

Although the major emphasis at Port Hueneme focuses on the provision of facilities for deep-draft vessels, a small section is set aside for the commercial fishing fleet and the port serves satisfactorily as a refuge harbor for small craft.

Originally the plans in 1940 called for Port Hueneme to accommodate pleasure craft, but requirements of national defense which resulted from World War II converted the choice harbor into a valuable naval facility. Fortunately, an admirable substitute, Channel Islands Harbor, was developed as a by-product included in a solution by LAD for the problem created at Port Hueneme, for, north of the port, sand produced by the alteration of wave patterns threatened to destroy Port Hueneme. Engineers at LAD not only built a sand trap to pass more than 2,000,000 yards annually around Port Hueneme to beaches at Point Mugu but they also incorporated a harbor entrance into the sand trap structures and excavated a harbor solely for the use of recreational and sport fishing purposes. Since 1961 each biennium the material is dredged from the sand trap and deposited downcoast to restore the shoreline.

Just a few miles north the Ventura Marina Port District, with financial assistance from the Department of Harbors and Watercraft, constructed the Ventura Marina, a harbor troubled by hazardous wave action at its mouth, which has caused innumerable boating accidents. Studies by LAD were underway by 1965 to determine how to correct the hazardous entrance problems. Thus LAD assisted in the development of a complex of three harbors in Ventura County, a development of tremendous importance to the population of that region.

Site for Channel Islands Harbor prior to start of construction. In the upper left background is Port Hueneme whose shoaling problem led to a solution which included a new harbor.

View of the completed Channel Islands Harbor (originally named Ventura County Harbor), Dec. 1, 1961.

Aerial view of Ventura Marina and the mouth of the Santa Clara River.

Just to the north of the Los Angeles International Airport lies Marina del Rey, one of the largest and most magnificent small craft harbors in the world, a fitting climax to a story that began in 1886. At that time the efforts of Moye L. Wicks and the Santa Fe Railroad to convert the estuary of Ballona Creek into a major world port failed. In 1916 LAD deemed a proposal to develop the inlet and basin, now named Playa del Rey, into a major harbor as impractical in view of its proximity to major harbors in San Pedro Bay. In the 1930's District officials reiterated that judgment.

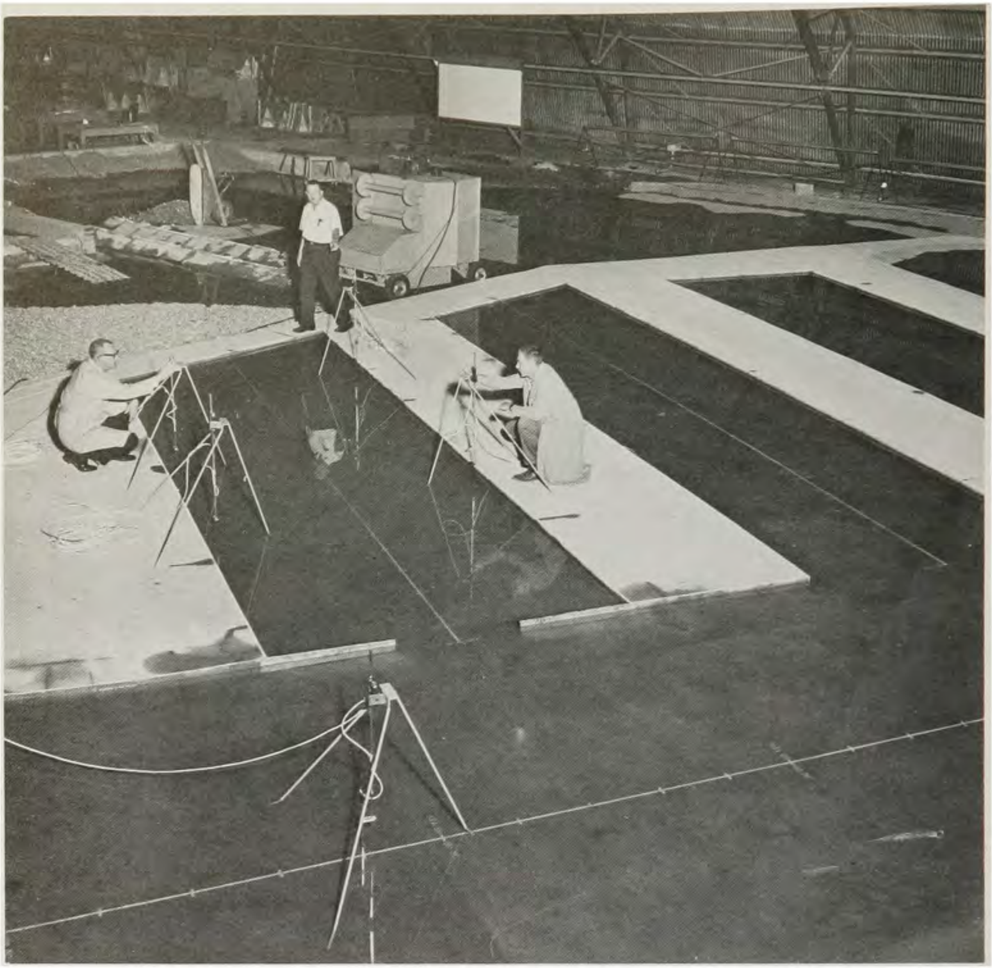
By the early 1940's, however, with attention focused on recreational boating, the location of a harbor at Playa del Rey, to provide a badly needed haven for the continually expanding fleet of small boats in Los Angeles County, was again proposed, but World War II temporarily stalled planning for the facility.

In 1948 LAD submitted a report which demonstrated the feasibility of constructing a small boat harbor, and authorization for the marina was approved in September 1954. The marina was developed as a joint project of LAD and the County of Los Angeles, with additional support from the State of California.

Before a satisfactory haven could be created, major problems had to be resolved. The most serious difficulty appeared after the harbor was placed into operation, when it was found that the harbor was vulnerable to seiche and surge action during heavy storms. The construction of relatively small harbors on open shorelines for frail craft was a new experience for the Coastal Engineering Branch and the Corps of Engineers in general. Therefore, deficiencies were to be expected. In particular Coastal Engineering was confronted with a lack of long term records, no proven method of recording wave direction, insufficient knowledge of how waves are attenuated within the harbor by bottom revetted slopes, or bulkheads, limited knowledge concerning wave energy buildup or dissipation due to interior configurations of the harbor, and lack of design criteria for small boat harbors. To resolve these problems engineers functioned with a phased program, first designing the harbor on the basis of the best information available, then proceeding with construction and evaluation, and finally designing any necessary remedial works.

Aware of the vulnerability of the harbor at Marina del Rey to wave action, LAD had underway a model study at the Corps of Engineers Waterways Experiment Station. After the harbor was opened for operation, it suffered severe damage during the winter of 1962-1963. LAD, on the basis of information obtained from the model study, suggested an interim solution to Los Angeles County which was

Marina del Rey under construction, view of completed entrance jetties, area to be dredged, and Ballona Creek flood control channel (Dec. 28, 1959).



Engineers seeking an answer to the surge problem at Marina del Rey position electronic wave recording gages in a scale model of the marina at U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., to test effects of constructed bulkheads at basin entrance.

Marina del Rey Harbor. Dredging and construction of entrance channel, jetties and offshore breakwater by Los Angeles District. Project completed in 1962.

implemented by the construction of temporary protective sheet-pile baffles in the entrance to the channel. The latter provided sufficient protection from wave action until permanent protective structures could be built. Following the lessons learned from the completed model study the engineers constructed an offshore breakwater and the baffles were removed. These remedial measures countered public criticism of the project and preserved the use of the harbor for the residents of Los Angeles County.

As one of the largest small craft harbors in the world, the Marina del Rey is an LAD achievement which matches the success of the large harbor complex of Los Angeles-Long Beach. To a writer in *Westways* (September 1966) the marina was "a near miracle." In addition the project demonstrated healthy cooperation between local, State, and Federal Governments.

Redondo Beach King Harbor, about 10 miles south of Marina del Rey, and also in Santa Monica Bay, was the first Federal recreation harbor to be completed in California after the Korean War. Fittingly, the harbor was named for Congressman Cecil King, for his determination obtained the Federal share of the construction funds for a harbor which began as a WPA project during the thirties. Before the harbor was dedicated on November 16, 1966, Coastal Engineering and consulting engineers had to provide remedial actions for the special problems of this harbor breakwater.

At one time, designers of breakwaters and jetties believed that wave energy produced by breakers and swells was confined to the amount penetrating through the porous upper structure of a breakwater into an inner harbor. The engineers discovered that this wave energy activated surge factors, particularly during storms, which made it impossible to prevent damage to boats or structures within the harbor at Redondo. To combat the seiche and surge during heavy storms, temporary baffles were erected which provided such excellent protection that they were left in place for added safety, although permanent corrective works were later completed by LAD.

To provide these works, Bill Herron and his associates in Coastal Engineering abandoned to some extent the "seat-of-the-pants" engineering and instead adopted a highly sophisticated approach which combined on-site study with several large-scale model tests to obtain designs which resolved some of the problems plaguing the project. The most important finding of the investigations was that a breakwater had to be designed which was relatively impermeable to waves. As Brigadier General John A. B. Dillard, District Engineer, related, Redondo Beach was a historic landmark in producing valuable design principles which were to be utilized in the construction of other small boat harbors.

Thus while King Harbor is not the type of harbor (a major deepwater one) the pioneer residents of Redondo Beach had hoped for, nevertheless, as a substitute, it fulfills a need that they did not anticipate. Certainly it is a harbor in which the city takes pride, and particularly as it is an integral successful part of its urban redevelopment program.

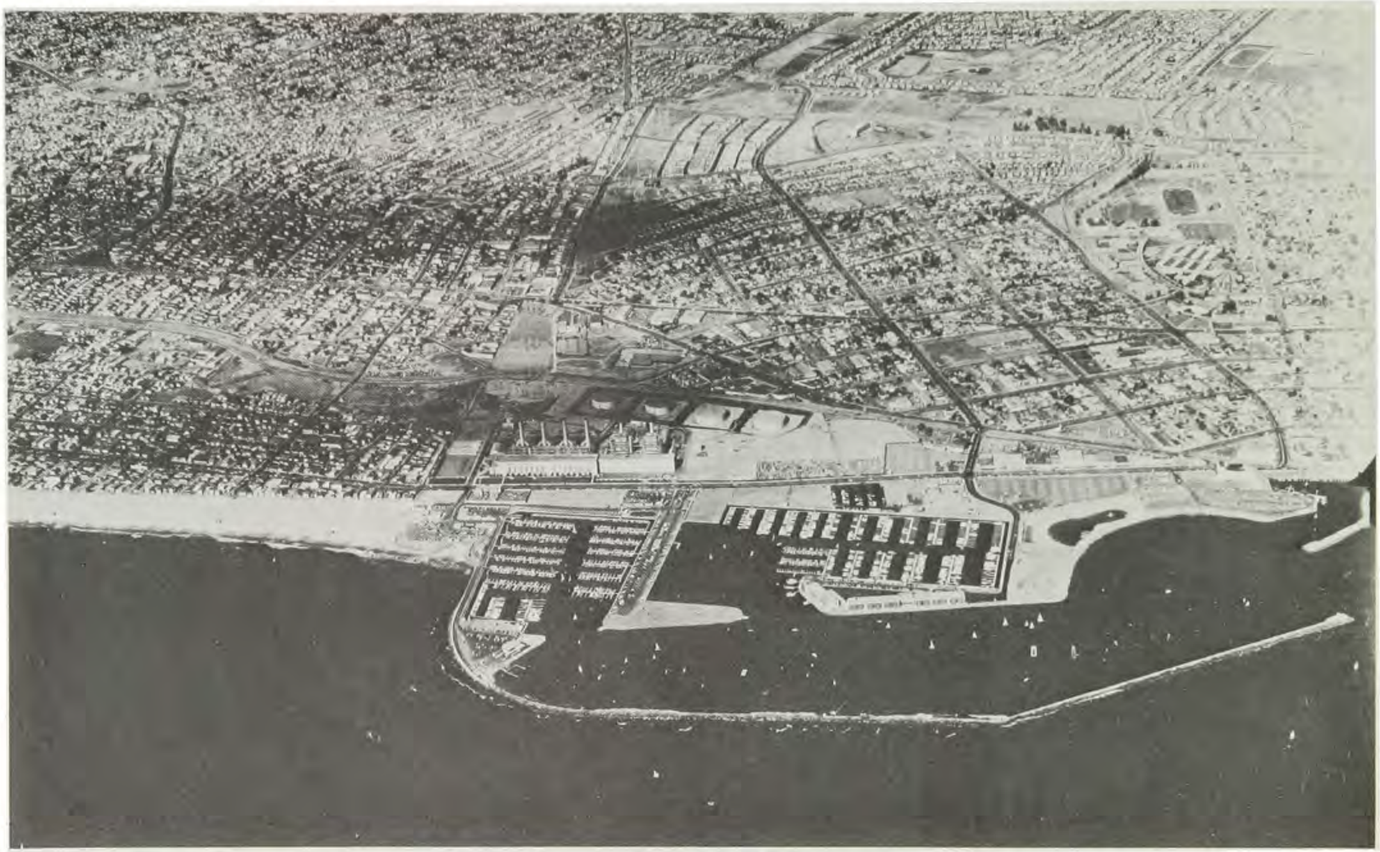
Although Federal improvements at Los Angeles and Long Beach Harbors had as their primary purpose the requirements of commercial shipping, the outer breakwaters, significant elements in those improvements, have created a semiprotected area which is probably one of the finest small craft sailing areas in the world. However, to satisfy the needs of commercial shippers, plans for the ultimate development of the twin harbors may reduce considerably the water area available inside the breakwater for recreational activities, but provision of more marina berthing facilities for small boats is planned.

Newport Bay Harbor, which lies about 24 miles southeast of Los Angeles and Long Beach Harbors, was the first one in southern California constructed for the exclusive use of small craft. The people of Newport Beach and vicinity began the construction of the small craft harbor at their own expense, after their efforts to obtain a favorable survey report failed. However, in September 1933 LAD, while stating that improvement of Newport Bay was not advisable, did conclude, that as a relief measure and with local contribution of one-half the cost, the project should receive favorable consideration. On that basis improvement was authorized by the Public Works Administration in June 1934 and by River and Harbor Acts in 1937 and 1945. Thus during the depression days a stable harbor with minimal littoral problems came into being, one of the most magnificent pleasure harbors in the world. Although completion of the existing harbor is still underway, LAD, in cooperation with local and State agencies, is carrying out studies to determine whether the harbor should be expanded into the upper part of Newport Bay.

Between the Newport and Long Beach Harbors are small craft developments at Anaheim Bay, or Alamitos Bay, built by the people of that area. Also nearby are the Sunset-Bolsa Chica Bays, with large marshy areas. The northern part of this area has been converted into a marina-oriented subdivision. The Orange County Harbor District also is developing marina-oriented park facilities, but navigation to the inland sloughs through the Naval Ammunition Depot, Anaheim Harbor, is rather difficult. Studies by LAD are underway to provide a suitable entrance to the entire marsh area in connection with a prospective offshore harbor development which would incorporate a proposed nuclear energy power and desalinization plant.

Redondo Beach coastline in 1938.

Typical storm hits the Hermosa-Redondo Beach area on Dec. 5, 1945.



Redondo Beach, King Harbor in 1964. Los Angeles District did construction and rehabilitation of breakwaters while local interests were responsible for harbor facilities.

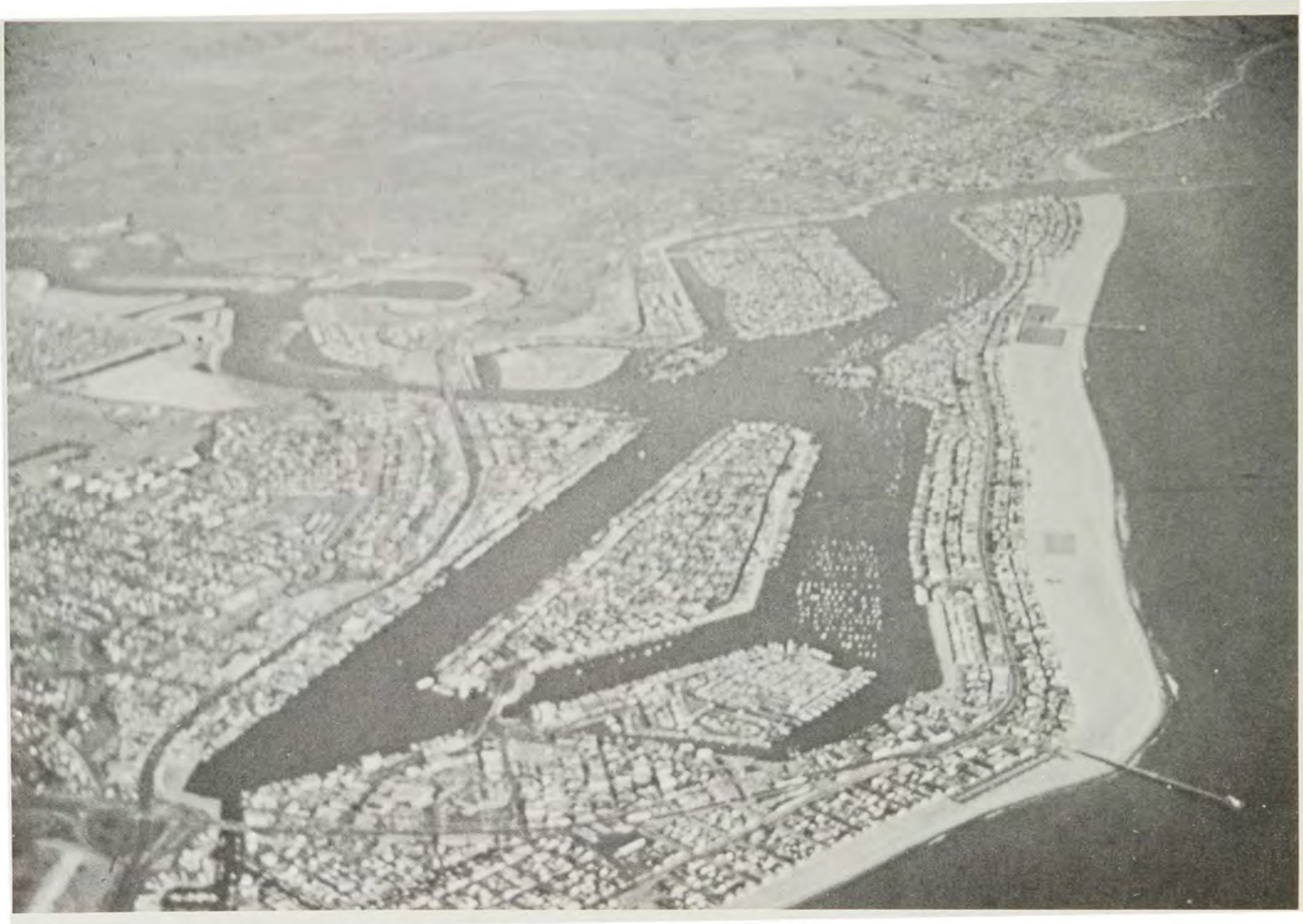
Small-craft moorings in East Basin, Los Angeles Harbor, 1959.

Twelve miles south of Newport Beach, LAD, in cooperation with the Orange County Harbor District, scheduled for completion in 1970 a small boat harbor at Dana Point which probably would astound Richard Henry Dana, who had written a caustic description of the southern California coastline, and for whom the harbor was named. This project was authorized by the 1962 River and Harbor Act. To anticipate possible problems, a large-scale model of the proposed harbor was made. Although the principles derived from the Redondo Beach Harbor project proved invaluable in the design of the Dana Point breakwater, they had to be supplemented by information extrapolated from the model study. At Dana Point a mole was built which acted as a solid secondary breakwater to absorb the energy created by waves either overtopping or coming through the breakwater. Completion of this Federal small craft harbor will eliminate one of the reaches of coastline between all-weather harbors of more than 35 miles, the distance agreed upon by all concerned agencies as desirable. Slips will be available for 2,500 small craft.

An unusual story unfolds with regard to the creation of Oceanside Harbor. In 1943 an excellent beach fronting the city became a war casuality with the construction by the Marine Corps of the Camp Pendleton Boat Basin. In anticipation of beach erosion city officials contracted for studies of the problem which were completed in 1949. The Corps concurred in the findings that the erosion was caused by the Marine Corps facility, but pointed out that the Federal Government under existing laws could pay only one-third of the cost of restoring the beaches. Alerted to this, city officials then began a crusade to have the Federal government pay all the costs. The campaign was successful, for in 1961 upon the advice of LAD, Congress approved the "Equity Project," a precedent-setting authorization for the government to pay 100 percent of the costs of restoring the beaches.

The City of Oceanside took advantage of this beach restoration project to develop a 540-boat recreation harbor. Since Federal funds were not immediately available, the enterprising city officials established another district precedent by obtaining authorization to have the State of California advance $1,750,000 interest free to the Corps so that work could begin at once. Finally in May 1963 an exceptionally low-cost harbor was completed. The indefatigable citizens of Oceanside did not stop at that. Next they obtained from Congress authorization to have the Federal government assume the maintenance responsibility, particularly to counteract the shoaling of the entrance channel of the combined Marine Corps Harbor and Oceanside Harbor. Thus Oceanside has an excellent recreational facility at low cost to its residents.

Aerial view of Newport Bay shows jetties at entrances to bay. Balboa Island is in the foreground, Oct. 16, 1938.



Aerial of Newport Bay, Jan. 1963.

Wave machine used in studies for Dana Point Harbor, U.S. Waterways Experiment Station, 1965.

San Diegans had feelings of frustration, as the development of the Los Angeles-Long Beach Harbors prevented them from capitalizing on their advantage of having the only large natural harbor in southern California, but about 10 miles from the San Diego Bay entrance lies Mission Bay which has been converted into one of the most captivating water-oriented recreational areas in the world. Even the inimitable Lieutenant Derby would be forced to discard his ironic prose to describe the transformation of False Bay. In the early 1850's Lieutenant Derby noted that with the exception of "two steamers that wheeze in and out once or twice a month, the calm waters of San Diego Bay remain unruffled by keel or cutwater from one year's end to another." Today myriad craft cover the bay. Mission Bay also is the only project which includes both flood control and navigation improvements, two primary civil works responsibilities of the Corps. This tourist attraction, coupled with others, has supplied an economic base to alleviate the earlier frustrations of San Diegans at the waste of their natural resource – the bay. Within San Diego Bay, a complex at Shelter Island, which began by utilization of dredging spoil to build the island, now is a haven for small craft.

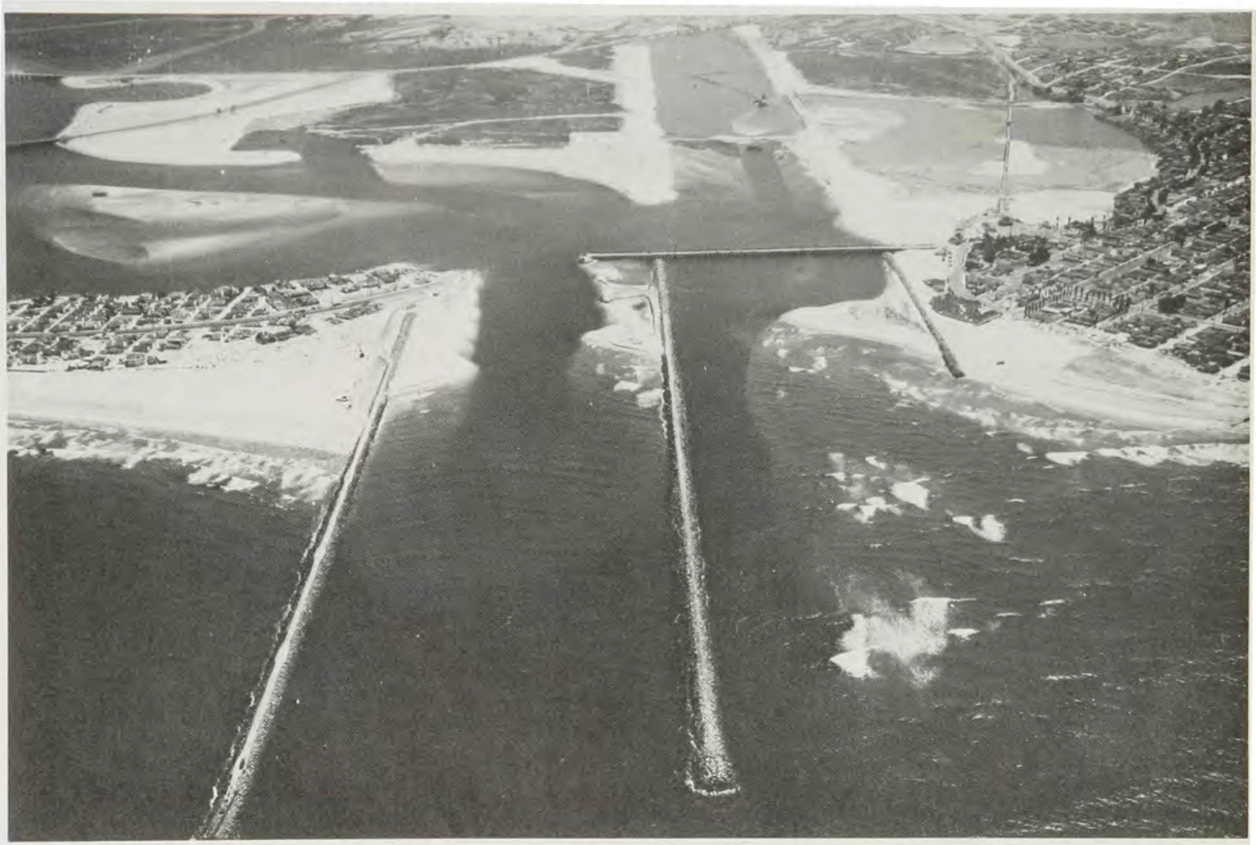
View of completed Oceanside Harbor with Camp Pendleton Boat Basin to the north, December 4, 1963.

Environmental issues will have to be decided before other Mission Bay type harbor and recreation complexes are developed in southern California. In addition to three lagoons at Camp Pendleton, there are six other fair sized coastal lagoons which will require public determination of final use, either for public recreation or retention as natural wildlife areas. These are Buena Vista, Agua Hedionda, Batiquitos, San Elijo, San Dieguito, and Los Penasquitos.

A combined survey report which covers San Diego Harbor and small craft harbor development in the vicinities of Glorietta Bay, National City-Chula Vista, and Roseville also is in progress. In addition LAD is formulating an overall, integrated coastal resources plan for the purpose of establishing or improving small boat harbors along the coast of southern California, including the Santa Barbara and Offshore Islands. The development of these offshore islands for recreational purposes would realize the full potential of these exciting coastal waters. The government of Mexico is also studying plans to construct coastal harbors in Baja California within cruising range of craft from southern California.

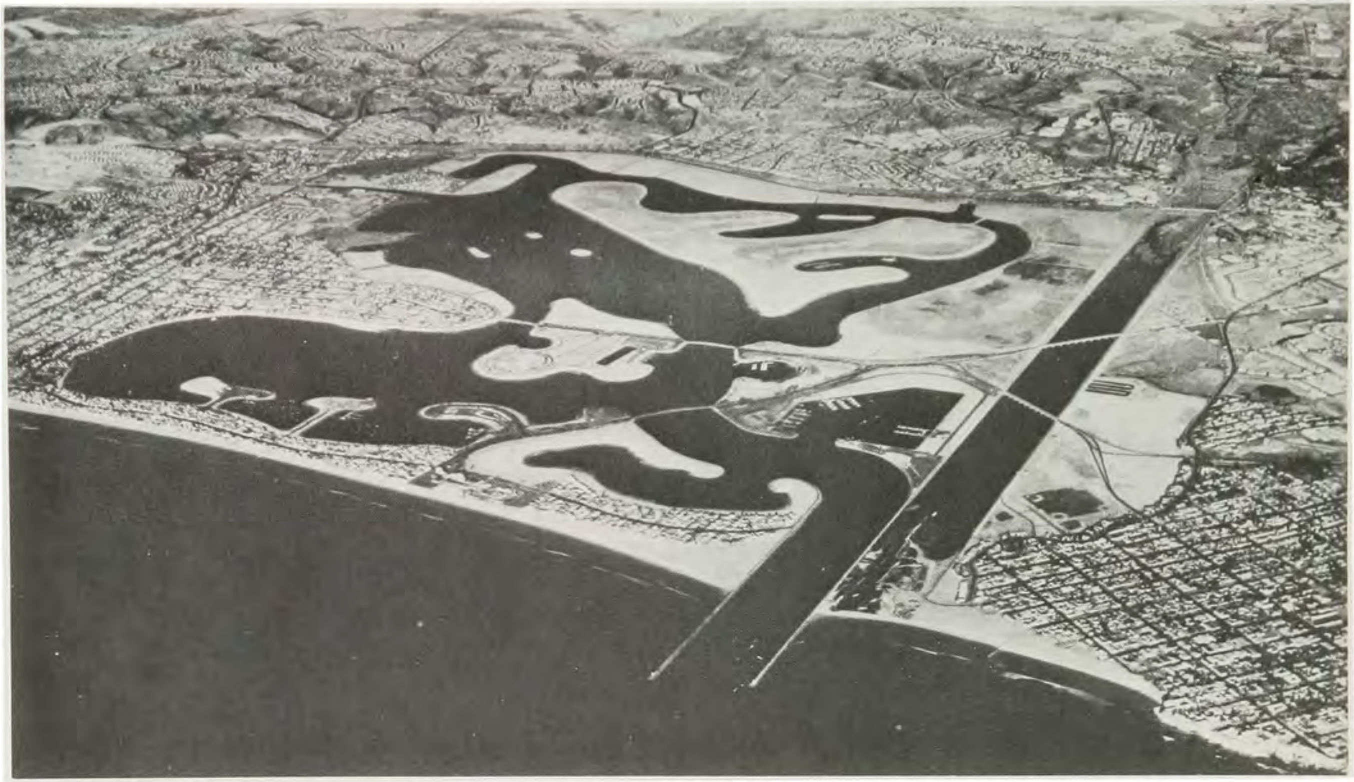
In addition to the navigable waters off the coast of southern California, recreational boaters now have available the waters of the lower Colorado River. Just as the river basin has provided a priceless source of water supply, it now also provides valuable water recreational opportunities.

Following the discovery of gold in California, one stream of emigrants came by a southern route which crossed the Colorado River near the present site of Yuma. What ultimately became Fort Yuma was established in December 1850 to protect these emigrants from Indians, support the members of the U.S. Mexican Boundary Commission, and garrison the country, but the fort had to be abandoned for lack of supplies. To resolve that problem, Lieutenant George H. Derby made a reconnaissance in 1850 up the Gulf of California which proved the feasibility of that route as a supply line. His advice was followed when the fort was regarrisoned in February 1852. Thus, to supply Fort Yuma, navigation of the Lower Colorado River began. In addition, settlers in the Arizona Territory utilized the steamboat service between the Gulf of California and Yuma and beyond, but only minor navigational improvements were made prior to 1900. By that time railroads supplanted steamboats in providing shipping services for the people of the Arizona Territory.



Aerial taken August 15, 1950, shows the south and middle jetties complete, with the north (left) jetty nearly complete.

Aerial view of flood control portions of the project displays the completed new U.S. Highway 101 Bridge at "A", the new Moreno St. Bridge at "B", and stabilizer at "C", with still uncompleted portion of levee at "D", and upper limits of the project at "E", December 31, 1951.



Mission Bay in 1963. Shown are the completed flood control channel (extending to the Pacific Ocean just off the lower right-hand part of the picture), the completed Federal navigation improvements, and the navigation and recreational improvements completed and under construction by local bodies.

Thus commercial navigation on the Colorado River declined. Commercial navigation on the river received its official demise in a Presidential Proclamation, 25 June 1929, which stated that "use of its waters for purposes of navigation shall be subservient to the uses of such waters for domestic, agricultural, and power purposes." This pronouncement was premature, for construction of significant multipurpose water projects on the river by the Bureau of Reclamation, with Hoover Dam as the initial project in 1931, created favorable conditions for a different type of navigation – recreational boating. By 1950 other factors like adequate leisure and additional income of the population, improved highways, and the availability of trailered boats further stimulated usage of the Colorado River for recreational navigation. These increased recreational demands restored the navigational responsibility of LAD on the river. In cooperation with the various interested agencies the district furthered the development of what Colonel Earl G. Peacock, District Engineer, in 1964 stated was "the unparalleled recreation potential of this relatively undeveloped river."

As Colonel Peacock warned, the Corps cannot adequately protect the Colorado River as one of the great pleasure-boating streams in the country without the support of local government agencies and the people. For its own part, in meeting that objective the District concentrated on improvement of the waterway by removal of shoals and bars, deepening of channels, removal of snags and obstructions, working on the problem of harbor lines, preparation of navigation charts, and making certain that ski jumps did not become obstructions. At the same time that the District works to satisfy recreational needs, it continues to do its best to preserve and protect a wonderful natural resource, the Colorado River.

A major continuous responsibility for the Corps is the issuance of permits for any work in, under, or across navigable waters of the United States. On the Colorado River, the District resolved problems like complaints about the slow opening of the drawbridge at Yuma for the safe passage of steamboats back in 1903 and the famous Cibola Bridge incident in 1958 which received nationwide publicity.

In the latter case, owners of property on the Colorado River constructed the Cibola Bridge, about 20 miles from Blythe, California, across the Colorado River in the spring of 1957, without obtaining the approval of the State authorities or LAD. As built, the bridge was an obstruction to navigation. Complaints about the bridge whose existence was previously unknown to the District placed the District in a very difficult situation. After thorough investigation the District proposed modifications to raise the bridge to meet the requirements of navigation

and flood control. But an entire year elapsed before the owners complied with this proposal. District personnel spent the year in taking innumerable field trips, holding a public hearing, and preparing reams of correspondence and reports. Finally to obtain compliance, the District requested the United States Attorney General to seek an injunction. Grudgingly the owners yielded. The patient and persistent efforts of LAD resolved the problem. This incident and others less frustrating illustrate how the District protects the boating public from the indiscriminate placement of obstructions detrimental to safe boating.

Work on the Colorado River continues to be a part of the concern of the District for the expanding needs for recreational boating facilities, an expansion truly phenomenal.

By law LAD in 1965 also had responsibility for the maintenance of water quality in all navigable waters. Major pollution problems exist at all waterfronts and marinas which attract a heavy stream of visitors to vista points, picnic and rest areas, maritime museums, restaurants, and varying types of exhibits. By constant vigilance, the District has obtained the necessary cooperation from local authorities to keep pollution under control.

In spite of the fact that berthing facilities for small craft in southern California will total 32,000 berths by 1980, the Coastal Engineering Branch of LAD predicts that actual needs by that date will require 47,000 berths because of population increase and public interest in boating. To reduce that deficit of 15,000 berths, coordinated planning by local, State, and Federal agencies is underway, with the ultimate objective of constructing many multipurpose harbors with berthing, launching and transient facilities, constructing more single-purpose harbors of refuge, adding facilities in the protected areas of existing navigable waters, and enlarging existing multipurpose harbors. Expansion and improvement of facilities at inland waters of the region also are contemplated. As usual, the mission of the Corps is a never-ending one. The staff in Coastal Engineering Los Angeles District can take pride in the "little miracles" they have created to enhance the living quality of the District.

CHAPTER IV

FROM HARBORS TO SHORE PROTECTION

Preservation of shorelines around the country has assumed dramatic importance recently for the Army Corps of Engineers, and the Los Angeles District reflects this concern by its attention to the coast of southern California. While water and wind are two of the most aggressive agents affecting beaches and coastlines, their erosive actions are supplemented by those of man. Every man-made facility on the coast or inland, economic or recreational, has an unknown impact. Recreational usage of the coast poses a tremendous challenge to the engineers involved in coastal management. The major coastal zone problem for LAD is to maintain beaches for the population which is concentrated increasingly in urban areas along the coast of southern California. This problem has peculiar characteristics. For example, in contrast to beaches elsewhere in the United States the beaches of southern California are not always nourished by sand washed in from the ocean. Instead, the beaches south of Los Angeles relied on three rivers, the Los Angeles, the San Gabriel, and the Santa Ana, for the replacement of sand which the waves of the Pacific Ocean constantly swept into some of the canyons off the coast. Originally, the concern of LAD was to control these rivers during rainy seasons to prevent their floodwaters from devastating the coastal plain of southern California. By the 1940's these rivers were tamed by forcing them into floodproof concrete channels, but this construction ended the natural replenishment of beaches. Resolving one vital problem developed a new one. Not too surprisingly, LAD exhibited an early interest in beach erosion problems, when in 1919 LAD examined the stream mouths in southern California discharging into the Pacific Ocean, particularly those open to tidewater, or which are deflected by a sand spit, or which had their mouths closed. In a memorandum, dated January-February 1919, Franklin Thomas recorded his observations on the mouths of Topanga Canyon, Malibu Creek, Laguna Canyon, Aliso Creek, San Juan Creek, Arroyo San Mateo, Arroyo San Onofre, Santa Margarita River, San Luis Rey River, San Elijo Lagoon, San Dieguito River, and the Ventura River. His inspections recorded the mouths for slope, quantity of flow, velocity, character of bed or beach material, direction of approach, longshore currents, littoral sand movement, cross section of stream, tidal prism, as well as photographs taken, hour of observations, and heights of tides. There are no indications what use was made of this beach erosion study, probably the first in the District.

The first Federal legislative interest in beach erosion occurred in 1930 when Congress, through the River and Harbor Act, authorized and

Malibu Canyon, California, looking northeast, is a major source of sand. Creek mouth and wind direction show eastward sand drift. (February 28, 1932, Spence Air Photo)

directed the Secretary of War to conduct investigations and studies to be made in cooperation with appropriate agencies of states, in order to devise effective means of controlling erosion of shores of coastal and lake waters by currents and waves. Under the Chief of Engineers, Congress placed the Beach Erosion Board, whose function was to investigate and report on the subject of shore protection. Among the early activities of the Board were studies of the California coast. Within the Los Angeles District studies were begun around 1934 to assist flood control districts plan their outlets at Ballona Creek and the San Gabriel River. A little later a study of the Santa Barbara coast by LAD led to one of the first successful sand bypassing operations which then served as a pattern for additional projects of this nature. During 1942 other cooperative studies covered sections of beaches at Coronado Beach and in the Mission Beach area at San Diego.

Within the Los Angeles District shore protection is the responsibility of the Coastal Engineering Branch, whose other area of concern is the planning of harbors. Since harbor developments disturb the shoreline, it is logical that beach erosion studies come under this branch. As William Herron, for many years chief of this branch, pointed out in 1958 in the *Los Angeles Times:* "Prior to the development of southern California, beaches along the coast were quite narrow, but stable. Then man stuck his foot in the ocean and the situation has been anything but static since."

Herron referred to problems of shore protection which result from the construction of piers, breakwaters, and commercial and pleasure harbors. These projects not only interfere with natural sand movement, but also set up new ocean wave patterns which can produce devastating results – sandy beaches disappear while bluffs and houses topple into the ocean as they are undermined by wave action.

As in other engineering situations which involved LAD, southern California presents its coastal engineers with peculiar problems. Beach erosion studies indicate that exceptionally heavy surf battering the beaches carries huge volumes of sand out to the ocean where much disappears permanently into offshore submarine canyons.

In the 1930's and 1940's several cooperative studies covering specified sections of the shoreline at Santa Barbara, Orange County, Coronado Beach, Long Beach and the Mission Beach Area of San Diego were made. The scope of each cooperative beach-erosion study varied widely, as local conditions dictated to a large degree the extent of the study and the data required. In 1943 the State of California created the office of Beach Erosion Control Engineer with major responsibility for preparation of master plans of shoreline development by the State and

Aerial view in 1938 of beach erosion downcoast from the Cabrillo Pavillion in Santa Barbara.

To retard beach erosion, engineers rely on revetments, groins, and sand replenishment. Stone revetment is in place at the foot of Milpas St. in Santa Barbara to protect the beach from the ravages of the ocean (1938).

Dredged sand covers the revetment and makes the beach usable again (1938).

Opposite Redondo Beach lies a submarine canyon which swallows up sand from the beach (1941).

Storm batters Redondo Beach in January 1944.

various coastal counties. The master plans of shoreline development for Los Angeles and Orange Counties were completed by 1946, but unfortunately not implemented.

Review reports by District Engineers in 1948, 1950, and 1952 summarized the results of cooperative studies of the problem areas of Orange County, Anaheim Bay Harbor, Long Beach, and Los Angeles. The field investigations for these reports conducted by LAD included the geologic history of the area, determination of wave characteristics along the shore, and surveying the shoreline. It was determined that the shoreline became relatively stable near the beginning of historic time and further erosion was dependent on the balance between losses of beach material caused by ocean waves and sand replenishment brought to the shore by the rivers. This balance could be upset by conditions, either natural or artificial, which could result in severe erosion.

Extensive flood control works, necessary to protect the people of southern California, intercepted most of the sand and bed load from the mountain areas. Thus these reduced quantities of materials from the rivers and streams were insufficient to meet the requirements for beach nourishment. This problem LAD has resolved with varying degrees of success, as the examination of how the District handled the 422 miles of shoreline which is its special concern will make apparent.

With the construction of the San Pedro and Los Angeles-Long Beach breakwaters, an 11-mile stretch of shoreline became protected and stable. However, because of man-made structures the shore alinement differed considerably from that existing prior to harbor development. The bulk of the new shoreline is in good condition and relatively stable.

Down coast from the mouth of the Los Angeles River, the shoreline has a different history. During the early days of Long Beach, the beach in front of the city remained comparatively narrow. After 1928 as a result of the construction of the Long Beach breakwater (later an integral part of Pier A) the river mouth was sheltered from wave action which in turn prevented the removal of delta deposits by littoral transport. After 1930 Rainbow Pier acted as a barrier to eastward littoral drift. After 1937 the Los Angeles-Long Beach detached breakwater protected the entire delta deposit from west and southwest wave action. Thus, detritus from the Los Angeles River no longer nourished the beach. The catastrophic 1938 flood built the Los Angeles River delta seaward. District engineers estimated that approximately 11 million cubic yards of sand accumulated in the delta from 1928 to 1939, which stabilized the adjacent beaches.

Sand Bar across the mouth of the Los Angeles River as a result of the March 1938 flood. Sand dredged from the mouth helped replenish surrounding beaches.

However, prior to the completion of the detached breakwater, waves approaching from the west eroded the beach immediately east of Rainbow Pier, denuding a 5-mile stretch of beach between Rainbow Pier and the San Gabriel River. In the period from 1944 to 1946 district engineers reconstructed the beach between Rainbow Pier and Belmont Pier with 3-1/2 million cubic yards of material dredged from the Los Angeles River delta, as part of the harbor maintenance plan.

Between the outlet of the San Gabriel River and Belmont shore, a barrier beach separated Alamitos Bay from the ocean. The barrier beach was enlarged into a habitable peninsula and the west end of the bay was filled with material dredged from the tidal marsh to form a lagoon for bathing and small-boat navigation. Obviously, beach erosion plagued the area. Cooperative efforts by the State of California, Los Angeles County, the City of Long Beach and LAD resulted in some success in curbing beach erosion. The City of Long Beach constructed a modern bulkhead along the ocean shore of the peninsula near its east end to protect the beach community there. To save the bulkhead from destruction by strong wave action, engineers dumped large stone into scoured areas

along its seaward face. Jetties built in 1932 and 1933 stabilized the river outlet. In 1944 a third jetty was constructed 600 feet west of the river outlet, the mouth of San Gabriel River was separated from Alamitos Bay, and a tidal channel from the bay to the ocean was dredged between the two up-coast jetties. In 1945 a series of five groins, each 240 feet long, spaced at 800-foot intervals, were built along the ocean front in the area sheltered by the wooden bulkhead. Then the spaces between the groins were filled with about 600,000 cubic yards of material dredged from Alamitos Bay by the City of Long Beach. Concurrently, a cooperative effort between Long Beach and LAD continued to pump sand from the Los Angeles River delta eastward to a point 1,000 feet east of the west end of Alamitos Peninsula bulkhead. Unfortunately, the sand deposited between the groins along the bulkhead moved upcoast around the groin ends at intermittent intervals so that by 1950 very little beach remained, an indication of the difficulty involved in resolving the problem of beach erosion.

Fronting the City of Seal Beach is a section of beach about 1 mile in length. After 1939 several developments occurred which altered the Seal Beach shoreline so that the beach was alined approximately parallel to and 300 feet eastward of the original shoreline that skirted the bluffs before 1936. Among the contributing factors were the movement of sand from the San Gabriel River delta downcoast until the completion of the offshore breakwater, whereupon the latter intercepted littoral-drift-producing wave action in the Seal Beach area, while the construction of a third jetty at the Alamitos Bay entrance in 1944 further limited eastward drift past that point. Furthermore, extension of

Groin field at Anaheim Bay completed in 1942.

View of temporary fill at Surfside, March 18, 1948, about three months after completion of dredging.

the Anaheim Bay west jetty by the United States Navy trapped all sand that had accumulated along the Seal Beach front. The new shore alinement remained relatively stable for several years.

Jetties placed to protect the entrance to Anaheim Harbor stabilized a 3/4-mile section of beach in that area. The Surfside-Sunset Beach, comprising a 2-mile segment, eroded rapidly. In 1947 the Corps restored this beach to excellent condition by depositing 1,097,000 cubic yards of dredged material.

The Bolsa Bay-Huntington Beach section of shore, several miles in length, remained in fair condition, except for an erosion area fronting the Huntington Beach bluffs. To protect the oil-well sites, stone riprap was placed along the shore to prevent bluff erosion from undermining these sites. Natural accretion widened the beach considerably in that area. At this time the Santa Ana River segment, a 4-mile section of shore downcoast from the Huntington Beach bluffs to the vicinity of the Costa Mesa bluffs at the west end of Newport Beach, was in fair condition.

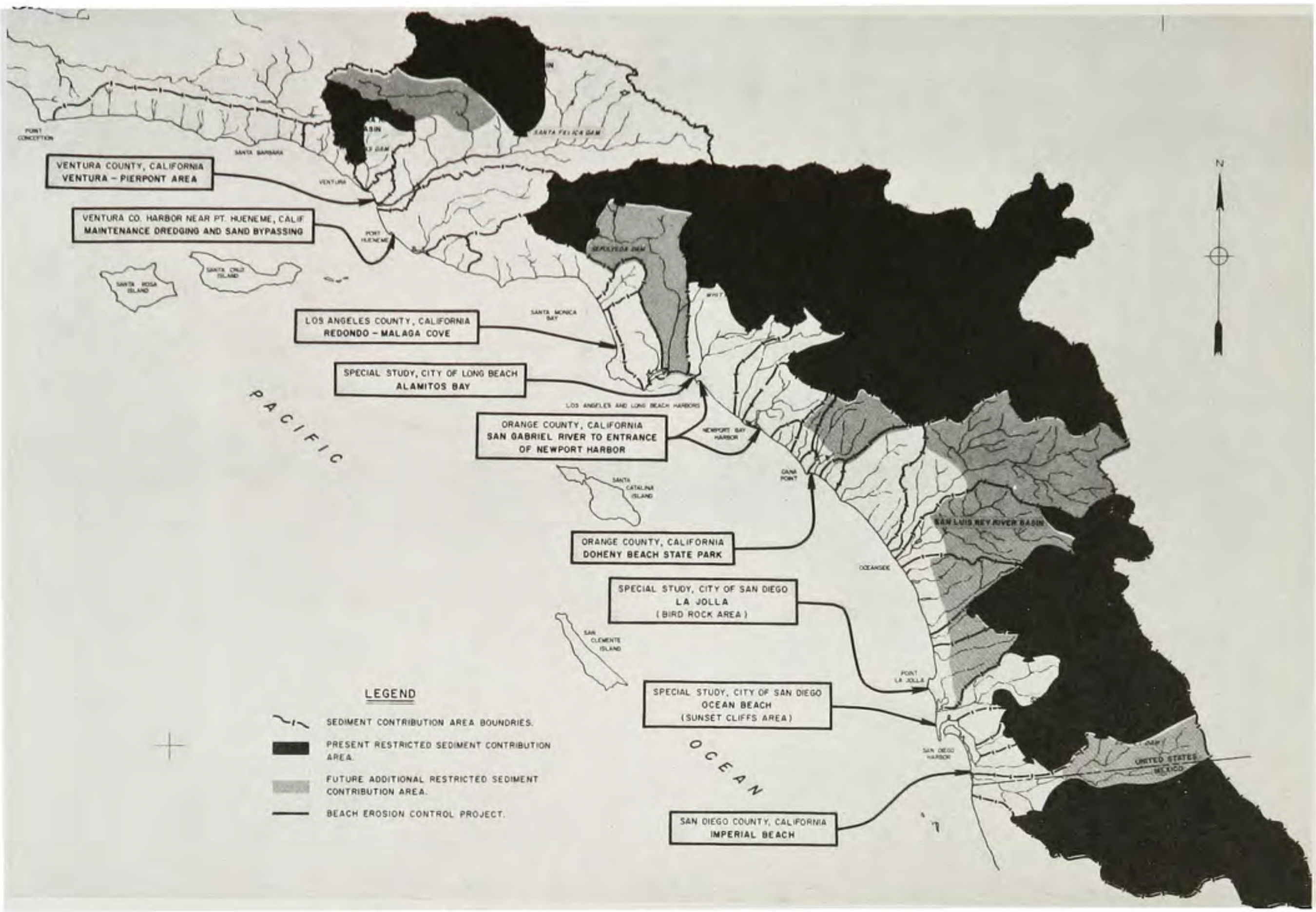
The West Newport Beach segment had suffered considerable erosion from 1926 to 1934. In 1935 about 1,900,000 cubic yards of material dredged from Newport Harbor by LAD restored and widened the beach. In its 1940 report the Beach Erosion Board considered that protective works would be required, but nothing was done so the shoreline advanced and retarded intermittently for varying distances up to 100 feet.

Originally there was a comparatively narrow barrier beach, separating Newport Bay from the ocean, whose fluctuations caused considerable alarm to the people settled on that highly desirable location, among the most expensive shore front property in the country. Between 1919 and 1932 local interests and, in 1935, the Corps of Engineers deposited material dredged from the harbor onto the beach which advanced the shoreline several hundred feet. In spite of the fact that the beach consisted of artificial deposits, it remained fairly durable for several years.

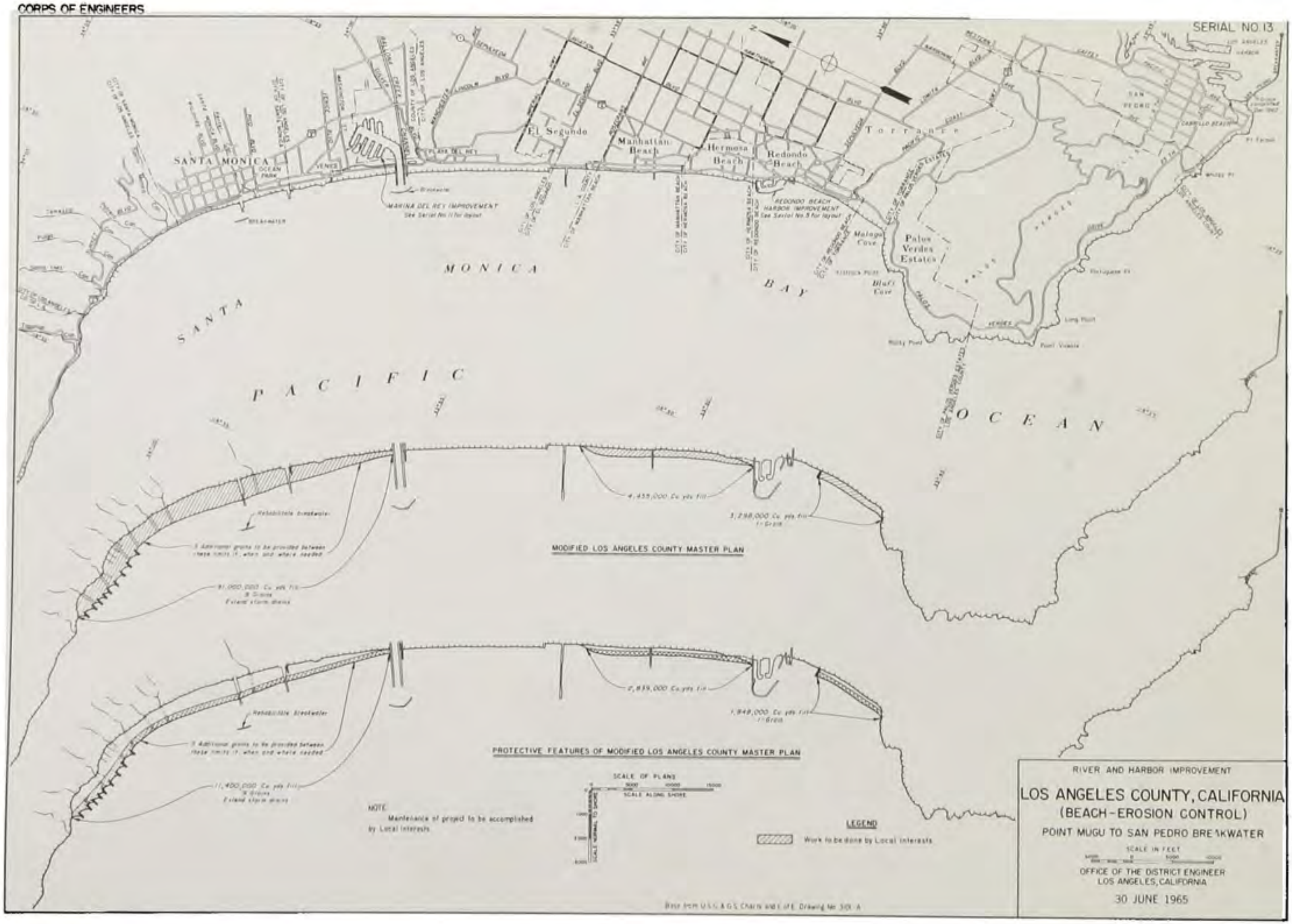
These early studies assumed that local interests would follow the recommendations of the studies for beach improvement, for under authority granted by Congress the Corps of Engineers could participate in projects for the prevention of beach erosion or for the restoration of eroded beaches only where Federal real property was resolved.

In 1956 to obviate this difficulty, the 84th Congress in Public Law 826 extended Federal aid to the protection of privately owned shores under certain conditions and Federal aid to periodic beach nourishment by classifying the latter as construction rather than maintenance. These changes were very significant to southern California where considerable portions of shoreline are under private ownership. This liberalization of Federal participation in beach protection programs and the conversion of the old Beach Erosion Board into the Coastal Engineering Research Center, coupled with the impact of natural disasters, augmented considerably this aspect of the Corps' mission.

The role of the Corps in coastal oceanographic research also became significant. After 1959, following a recommendation for a greatly increased oceanographic research program for the country by a special committee of the National Academy of Sciences, the Federal Government accelerated its role in that program. The Corps of Engineers received the major responsibility for that part of the Federal research program dealing with shallow water or coastal oceanography. This function involved certain sub-agencies of the Corps – the Coastal Engineering Research Center, the Waterways Experiment Station, the Lake Survey District, and the Committee on Tidal Hydraulics – as well as the traditional districts and divisions.



Map, Data on Sediment Contributary Area (1965).


SERIAL NO. 13
SANTA MONICA
El Segundo
Manhattan Beach
Hermosa Beach
Redondo Beach
Torrance
Palos Verdes Estates
SAN PEDRO
MARINA DEL REY IMPROVEMENT
See Serial No. 11 for layout
REDONDO BEACH HARBOR IMPROVEMENT
See Serial No. 8 for layout
Malaga Cove
Bluff Cove
SANTA MONICA BAY
PACIFIC OCEAN
MODIFIED LOS ANGELES COUNTY MASTER PLAN
4,455,000 Cu yds fill
3,298,000 Cu yds fill
91,000,000 Cu yds fill
Rehabilitate breakwater
PROTECTIVE FEATURES OF MODIFIED LOS ANGELES COUNTY MASTER PLAN
2,839,000 Cu yds fill
1,848,000 Cu yds fill
11,400,000 Cu yds fill
SCALE OF PLANS
SCALE ALONG SHORE
NOTE:
Maintenance of project to be accomplished by Local Interests.
LEGEND
Work to be done by Local Interests
RIVER AND HARBOR IMPROVEMENT
LOS ANGELES COUNTY, CALIFORNIA
(BEACH-EROSION CONTROL)
POINT MUGU TO SAN PEDRO BREAKWATER
SCALE IN FEET
OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA
30 JUNE 1965

In line with the above programs LAD not only continued its work in beach erosion, but also conducted a research and data collection program for the shores and beaches of southern California, an area unique in its ecology, science, and problems.

In 1964 Colonel Earl G. Peacock, District Engineer, summarized the work of LAD in these areas. He pointed out that with the ultimate objective of reexamination of the Pacific Ocean shore of southern California from Cape San Martin to the International Boundary several survey-studies of beach erosion were carried out to pinpoint areas of active or potential erosion, and to obtain data on shore processes and problems and wave data.

Studies were completed for the areas Carpenteria to Point Mugu, Point Mugu to San Pedro Breakwater, Alamitos Bay (Long Beach), San Gabriel River to Newport Harbor, Newport Harbor entrance to San Mateo, and San Diego County to the International Boundary. As a result, LAD acquired a considerable amount of significant engineering data. In August 1960, September 1961, and March 1964 periodic vertical aerial photographs of the coastline from the International Boundary north to Point San Simeon were taken and placed on file. In 1960, 1962, and 1963 ground photographs were taken at about 130 locations and also placed on file. LAD prepared two statistical wave studies "Wave Statistics for Seven Deep Water Stations Along the California Coast," and "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters," both of which are available to the public.

Colonel Peacock also reported on two invaluable studies concerned with shore erosion processes. One study collected littoral sand movement data for the purpose of obtaining engineering criteria for the design of a breakwater, groins, and beach fills in the Santa Ana-Newport area of Orange County. The second, which also was to be part of a coastal engineering wave study of the Pacific Coast from the Canadian border to the Mexican boundary, collected basic data applicable to general shoreline processes.

In addition, LAD has continued to carry out other research assignments for CERC. One project required cooperation between the State of California, CERC, and the Coastal Engineering Branch of LAD. The latter coordinated the collection of observation data on beach erosion by all parties and forwarded the information to CERC for evaluation. In another cooperative project, this one with the Atomic Energy Commission as well as CERC, the District utilized a research technique known as the "Radioisotopic Sand Tracer" in which selected sand samples are tagged with low-yield, radio-active material, thus

permitting littoral movement to be tracked by detection equipment designed to operate in a salt water environment. Several such field experiments along the southern California coast have been inaugurated since 1965. Of importance to a pollution-conscious public is the use of a harmless radioisotope of gold which cannot enter the biological chain.

Although groins are a favorite method used by engineers to combat erosion, their design, configuration and placement often are based on inaccurate data. CERC and LAD have built an experimental groin at Point Mugu to determine, first, how a groin functions and manages to entrap sand; secondly, how the shape and dimension of a groin affect the volume of entrapped sand. Finally, observations will be made of how sand moves over, around or through a groin. As Lieutenant Colonel Robert C. Riese hopefully concluded, "the experiment will unlock the door of knowledge and understanding of elusive sand and beach movement."

CERC also has funded a study on surfing, an extremely important recreational activity in southern California. Under this project, the District will classify and catalogue the coastline as to usage, type of terrain and features contributing to good surfing, and the economic impact of surfing.

Thus, to prevent poor engineering judgment which in the past often led to damage, not only to a particular beach, but also to an entire coastline, the Corps has launched a two-fold attack: studies of special problems which demand particular solutions, and studies which involve generalized research applicable to problems common to all coasts.

In the meantime the District has relied heavily on the experience of the personnel in Coastal Engineering to arrive at sound prescriptions to bring under control the powerful, destructive tendencies of the Pacific Ocean upon the coast of southern California.

In particular, the 12-mile stretch of shoreline from Anaheim Bay Harbor downcoast to Newport Bay Harbor, plagued by severe erosion, has proved a stimulating challenge to Coastal Engineering. Recreational needs of increasing population demanded both harbors and beaches. As usual, upon the engineers rested the resolution of problems.

A temporary solution devised by Coastal Engineering was to dredge sand from the bottom of Anaheim Bay to restore beaches periodically devastated by storms. This solution was complicated by the presence of a deep underwater canyon off Newport Beach with a voracious appetite for sand.

Condition of beach after a storm, January 25, 1952, Seal Beach.

Cliff collapsing, Sunset Cliffs, 1966.

Eroded area between 48th and 38th Sts., Newport Beach, 1965.

Loss of shoreline, Capistrano, 1965.

Storms in 1962 and 1963 created a near-disaster condition at these beaches. By dredging the Naval Harbor at Anaheim in 1963-1964 and placing the dredged material on the beaches, LAD salvaged this prized recreational area.

In 1963 Bill Herron and his colleagues proposed a more lasting remedy. They proposed the deposition of about 3 million cubic yards of suitable beach-building material on Surfside-Sunset Beach and the building of a single detached offshore rubblemound breakwater paralleling the shore just off the underwater canyon. Thus sand would be trapped in the breakwater trap and be available for restoration of the beach. The project was modified by relocating the proposed breakwater near the mouth of the Santa Ana River by constructing four stone groins between the river and Newport Pier, by depositing about 585,000 cubic yards of sand upcoast from groins 3 and 4, and by increasing to 4,000,000 cubic yards the placement of sand on the Surfside-Sunset Beach.

The original program operated in stages. Stage 2 construction, besides the placement of sand, also comprised the construction of an experimental steel sheetpile groin and a surveillance program to study littoral drift before proceeding to the next stage. This study delayed the construction of the breakwater and four stone groins. The success of test groins in holding sand, thus stabilizing the adjacent beach, led the Corps to construct the other rock groins as proposed in the original project. Final decision on the construction of the breakwater is still in abeyance until scientific justification is available.

The District also relied upon groins to stabilize beaches at Doheny Beach State Park, Imperial Beach, and Ventura Pierpont. Federal study and participation also are involved in a modified master plan for the protection of the shoreline from Topanga Canyon on Santa Monica Bay to the San Pedro breakwater at Los Angeles Harbor.

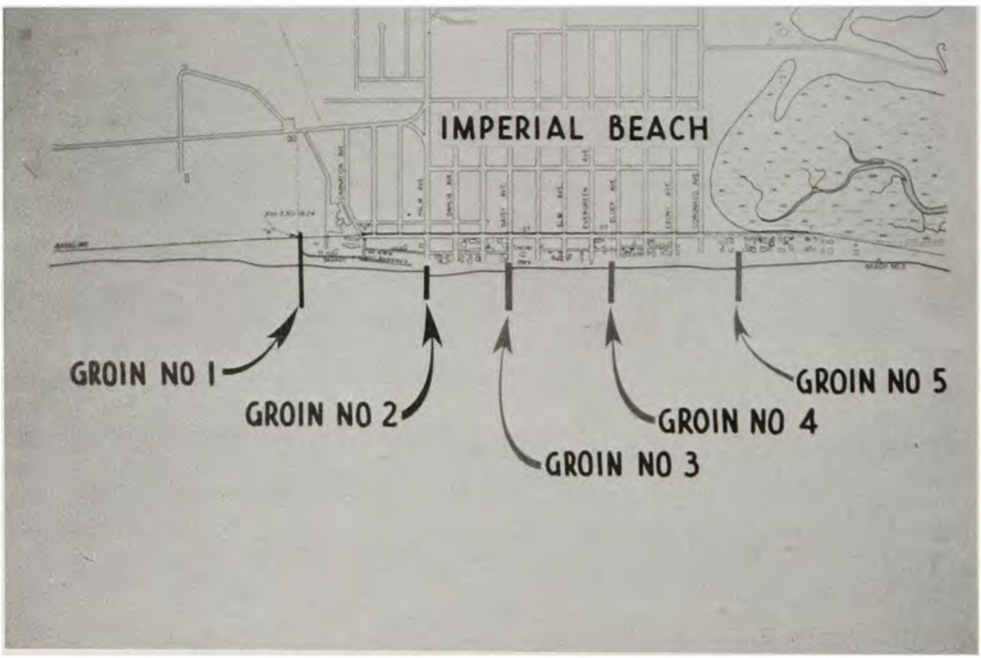
An excellent case study of how the Los Angeles District functions is the Cooperative Beach Erosion Control Project for the Ventura-Pierpont area, Ventura County. Robert L. Harris, Chief, Shore Protection Section, Coastal Engineering Branch, prepared an excellent report on the project from which the following is drawn. The problem area is a stretch of sandy beach which extends from the mouth of the Ventura River near the upper limits of the City of Ventura downcoast about 8 miles to the mouth of the Santa Clara River. The original beach which was relatively narrow during the beginning years of the 20th century widened considerably in 1914 and 1916, the result of floods and extensive runoffs from the above-mentioned rivers. Since the broadened beach was desirable for recreation and home sites, it was converted into

Stone groin at harbor breakwater to combat erosion at Cabrillo Beach, Los Angeles Harbor (1962).

Completed fill project for Surfside-Sunset Beaches (1965).

Waves breaking on groin, Imperial Beach (1961).

Aerial view of groins, Imperial Beach (1963).



Plans for strategic placement of groins, Imperial Beach (1964).

the Pierpont Bay development in which many beach homes were constructed after 1926.

Up to 1936 the beach area remained fairly stable as erosion and accretion were about equal. In that year and the ensuing one severe storms with resultant high waves severely eroded the area, with the resultant losses of several buildings and a paved street nearest to the ocean. This occurrence temporarily impeded growth of the community, but after World War II the Pierpont Bay section, downcoast of San Pedro Street at Whiteharen Court and shoreward to the cliffs, became one of the finest beach residential areas in southern California.

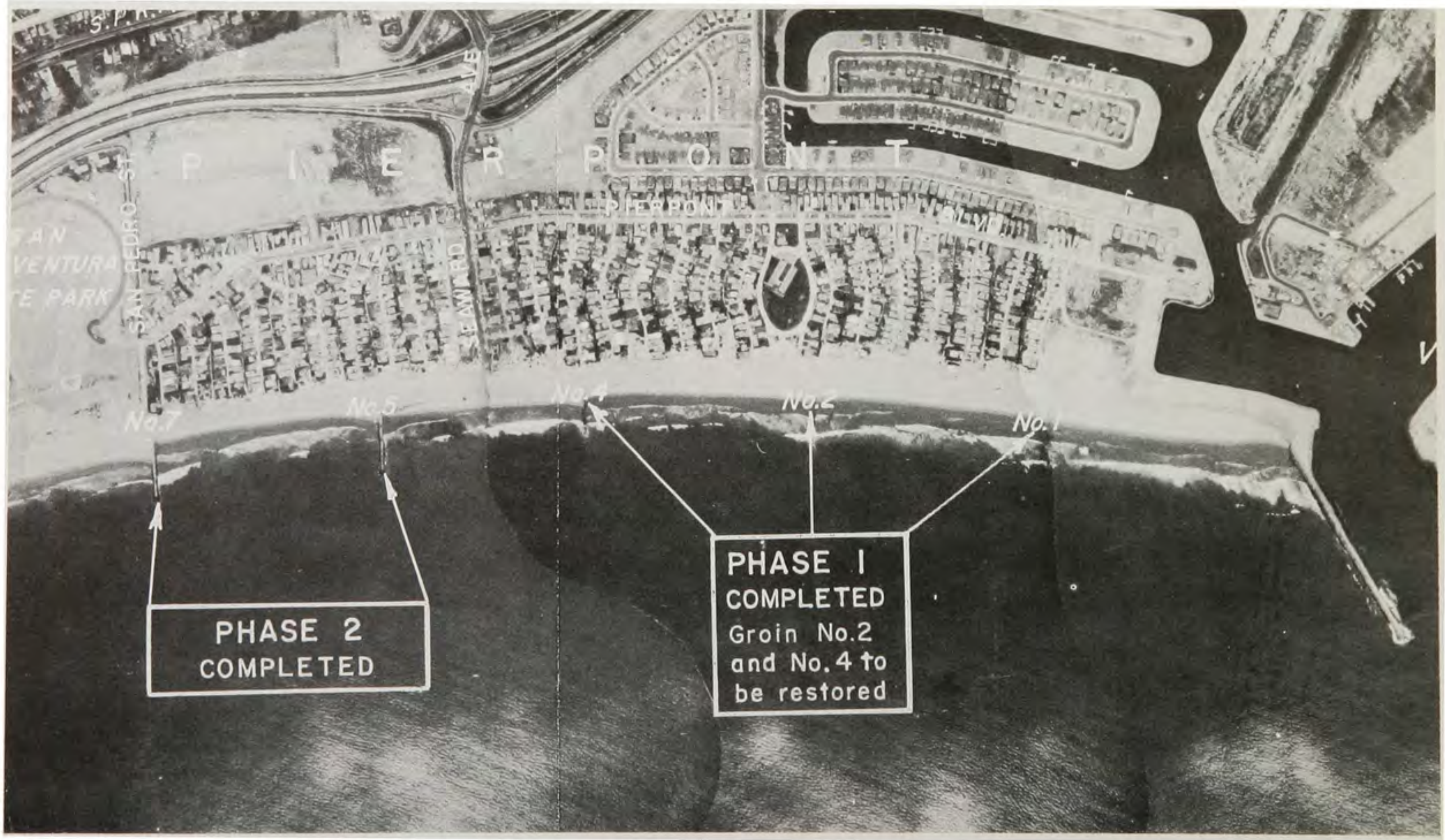
After World War II the State of California acquired the entire beach area from above the Ventura fishing pier downcoast for about 5 miles, a fine, continuous, publicly owned recreation beach known as the San Buenaventura Beach State Park.

Unfortunately, wave action and littoral drift narrowed severely and covered with the cobbles the recreation beach. Alarmed residents also feared that the beach recession would continue until their colony disappeared. The community requested the Federal government, in cooperation with the State of California, to make a beach erosion study to determine extent, rate and cause of erosion for the purpose of developing the most suitable remedial measures and to recommend what share of the costs each level of government should bear.

In February 1961 LAD under proper Congressional authorization initiated the study. Coincidently, just prior to the initiation of the study, a combination of storm waves, strong onshore winds, and high tides badly damaged the Ventura-Pierpont Bay area. After assessment of the damage, LAD recommended that remedial measures take place immediately.

The initial authorized project provided only three groins near the upper limits of the bay area and made no provisions for beach fill. To afford more extensive protection for the residential area which was subject to immediate danger from subsequent winter storms, the Chief of Engineers modified the plan of action by relocating the three groins further downcoast. To provide sand fill between the groins, an item not included in the authorized project, the State of California in cooperation with the County of Ventura appropriated the necessary funds.

With a mild winter in 1961, the area escaped further damage. In February 1962 the first groin and the sandfill portion of the project were constructed. This work was augmented when Congress authorized an expanded project to include a system of nine stone groins with



Aerial Mosaic, Shore Protection Improvement, Ventura-Pierpont Area (1965).

Completed construction of three groins, Phase One, Shore Protection, Ventura-Pierpont Area.

adjacent beach fills, extending along the entire bay area from the Ventura fishing pier to the outer limits of the residential area. This enactment also increased the percentage of Federal share in this type of work from 33-1/3 to 50 percent, thus easing the financial burden for local governments in shore protection measures.

LAD placed into operation a three-phase approach. Phase One, completed in June 1962, consisted of three groins, Nos. 1, 2, 4, and adjacent beach fill. Phase Two, finished in February 1965, completed groins Nos. 5 and 7 with adjacent beach fill. Phase Three with a completion date in March 1967 called for the elimination of groins Nos. 3 and 6, rehabilitation of groins Nos. 2 and 4, removal of deteriorated groin No. 1, and construction of two groins, Nos. 8 and 9 with adjacent beach fill.

Harris concluded that this comprehensive cooperative beach erosion control project, after completion and continuing adequate maintenance, would provide not only shore protection, but also an adequate beach area for use by the citizens of Ventura County "now and in the future."

In August 1963 Colonel Peacock submitted a breath-taking report on a cooperative beach erosion investigation in the Malibu-Santa Monica Area, in response to the request of the California Department of Water Resources and California Department of Public Works, Division of Highways, for a feasibility study of proposed marine locations for State Highway Route 60 and their shoreline effects.

The Division of Highways had determined that the traffic-carrying capacity of the existing Pacific Coast Highway required expansion to cope with anticipated traffic demand. Since the existing right-of-way of the highway between Olympic Boulevard in Santa Monica and Malibu Point, a stretch of about 12 miles, is not wide enough to permit the necessary broadening, a new location for the proposed Route 60 is necessary. Taking advantage of the problem, the local and State agencies involved requested the Los Angeles District to produce a master plan of utilization of beach property in the Santa Monica Bay area that would fulfill both the highway and recreational needs of the people.

A prior study in 1960 had concluded that there are three basic locations – inland, offshore and onshore. The latter two locations are adaptable to joint highway-recreational development. Colonel Peacock envisaged resolution of the problem of highway expansion by an offshore causeway which also would provide for all types of aquatic recreation as well as sheltered waters for berthing and sailing small craft. The study concurred with him that the proposed facility would enhance the recreational potential of this area; that construction of the proposed

freeway as a causeway was feasible in an engineering sense; that further study of engineering feasibility of an alternate plan, which called for a perched beach, was warranted; that annual maintenance costs were manageable; and that building the project under any of the proposed plans did not pose unsurmountable problems for the construction industry. As yet, the general public has not determined the fate of the imaginative recommendations.

Thus, it should be apparent to even the most biased of critics that LAD not only cooperates with local and State authorities and concerned citizenry, but also initiates programs to protect the environmental integrity of the scenic coastline of southern California. Without these cooperative efforts of the District, proper utilization and conservation of the esthetic and recreational qualities of invaluable coastal resources would be impossible. The 40-year record in the protection of shorelines is difficult to match by any institution, public or private. Not content with that record the Coastal Engineering Research Center and the Los Angeles District continue innumerable experiments to unlock the door of knowledge and understanding on elusive sand and beach movement, in order to preserve the beaches, harbors, residential and scenic areas of southern California for the rapidly growing population of the area.

CHAPTER V

FROM SHORE PROTECTION TO FLOOD CONTROL

Since the Los Angeles District area is semiarid, floods sometimes did not occur for a number of successive years which raised the inevitable question of whether flood control systems were necessary. Rapid urban development in California, Arizona, and Nevada in the 20th century, with inescapable encroachment on overflow paths and even flood channels, placed on governmental authorities the ever-growing responsibility for preserving life and property from floods. To resolve the problem, local authorities needed the assistance of the Federal Government.

Although the Constitution of the United States provided for regulation of commerce which laid the basis for improvements of navigable waters, it did not expressly authorize flood control. However, navigation and flood control were so inter-related that flood control became an important part of the work of the Army Corps of Engineers. Flood control was authorized under acts of Congress for navigation improvements.

In fact the very first civil works project in what became the Los Angeles District, authorized in 1852, demonstrated the relationship between navigation and flood control. The major purpose of the levee completed by the humorist, Lieutenant George H. Derby, was to prevent silting of San Diego Harbor by diverting the San Diego River from San Diego Bay to False (Mission) Bay. Destroyed by floodwaters, the dike was rebuilt in 1875 and not only carried out the original purpose, but also provided partial protection against floods to what became a highly developed urban area. In the 1880's and 1890's improvements in navigation of the Colorado and Gila Rivers also included flood control. Another navigation project involved flood control work. On August 8, 1917 Congress authorized the Los Angeles River diversion channel, routed through the City of Long Beach to eliminate silting of the Los Angeles-Long Beach Harbors. LAD completed the silt-diversion works in 1923.

In the meantime Congress in 1910 assigned the first pure flood control project to the Corps. That project called for control of floods, removal of debris, and improvement of the Sacramento River. The next authorization of a flood control project was for the Mississippi River in 1917. This act also reinforced the principle of federalism as it called for "local cooperation," which required local interests to furnish all rights-of-way and not less than one-third of the cost of construction and repairs.

The 1927 Act, with modifications in 1928 and 1935, authorized flood control investigations on all navigable streams and their tributaries, except the Colorado River system. With the passage of the Flood Control Act of June 22, 1936 the Corps of Engineers received official charge of Federal flood control activities. By that time the Corps had prepared thousands of flood control studies throughout the United States. With this experience as well as its remarkable engineering record, it was logical that the Corps of Engineers was the agency given responsibility for the design and construction of flood control works throughout the United States.

Moreover, the services of the Corps were invaluable in the battle to overcome the disastrous economic depression of the 1930's. Federal participation in the construction of flood control improvements in the Los Angeles District started in 1935 when an application of the Los Angeles County Flood Control District to the Works Progress Administration for financial aid was approved. Among the conditions for approval were requirements that the work be executed by the War Department under the Chief of Engineers and that 90 percent of the labor be obtained from relief rolls.

The year 1935 was of considerable significance for the Los Angeles District. Until that time LAD required only a small force to supervise the Federal river and harbor projects in the District. In 1 year, from the summer of 1935 to the summer of 1936, District personnel increased from about 15 to nearly 17,000 with more than 95 percent of the personnel coming from relief rolls.

That this fantastic transformation took place without too much confusion or loss of efficiency is a tribute to Major Theodore Wyman, Jr., CE, who arrived in August 1935 as the new District Engineer. The reorganization required careful planning and selection of personnel to fill the key positions. To aid in organizing and getting the work under way in LAD, Major Wyman obtained engineer employees from other districts, from the Federal Emergency Relief Association, and relief rolls.

At this time, individuals like Harry W. Thompson, William J. Leen, Gordon A. Lilley, Oliver H. Ochsner, Deming W.Morrison, Frederick C. Bennett, James G. Jobes, Edward Koehm, and George Arndt began their long years of distinguished service for the Los Angeles District. Flood control work in the Los Angeles area will illustrate the success of the reorganization plan.

As James G. Jobes stated in an address,"Lessons From Major Disasters," June 15, 1939, many people were surprised to learn that

"the Los Angeles area from the standpoint of value of damage, experienced or potential, per square mile of flooded area is the most outstanding of any area in the United States and possibly the world." The flood situation in southern California differed considerably from that encountered by Corps personnel in other parts of the United States, where, generally, flood-producing areas were not in as close proximity to an urban area as in southern California.

Because of geographical location and physiographical and meteorological features, the area is subject to extremely severe, periodic floods. One river, the Los Angeles, about 50 miles long, with a source 1,000 feet above sea level is not only at the same elevation as the mighty Mississippi River but also has the same amount of drop in its relatively short length as the Mississippi in its entire course. Flood destruction is further aggravated by the density of population and concentration of wealth in overflow areas. Major N. A. Matthias related in 1939 and 1940 that high velocities and heavy debris loads of flood discharges, unstable flood channels, the encroachment of urban and suburban development in the foothill and valley areas, and the absence of suitable reservoir sites for flood control combined to create a unique problem in design for District staff.

Los Angeles County, the major urban area in southern California, with a Pacific Ocean frontage of 70 miles, comprises about 4,000 square miles. The San Gabriel Mountains with peaks up to 11,500 feet are within the northern county boundary. Metropolitan Los Angeles occupies a 25-mile wide coastal-plain area which is hit by major storms during the rainy season, November through April.

Historical references reveal that between 1815 and 1876 eight major floods struck the Los Angeles area. Between 1884 and 1938 nine more floods are authenticated by records. Prior to 1914 there is little evidence to indicate that their occurrence made much of an impression on the inhabitants of the area, for no particular demand for a solution to the flood problem was aroused. The flood in 1815, for example, cut a channel across what became the business district of Los Angeles, forcing the Los Angeles River to enter the ocean by way of Ballona Creek. When in 1825 the river changed to its present channel, the city blithely expanded by building in the old 1815 channel. In addition, natural overflow areas were encroached upon, while small communities were placed on debris cones along the base of the mountains.

The flood in 1914 awakened the more far-sighted residents through whose efforts the Los Angeles County Flood Control District was established in 1915. A flood occurred in 1916 which made it possible to pass a substantial bond issue for the actual construction of flood control

The 1884 flood caused some loss of life and relatively heavy property damage, destroyed bridges, and washed away fifty houses. As a result of greater development later floods caused greater damage. The pictures dramatically demonstrate that normally dry channels do carry devastating loads of water at times of heavy rainfall.

Flood waters of the Los Angeles River in 1884 left horse car No. 5 in a precarious position. Photo courtesy Los Angeles County Flood Control District (LACFCD).

First St. bridge over Los Angeles River after the flood of 1884.

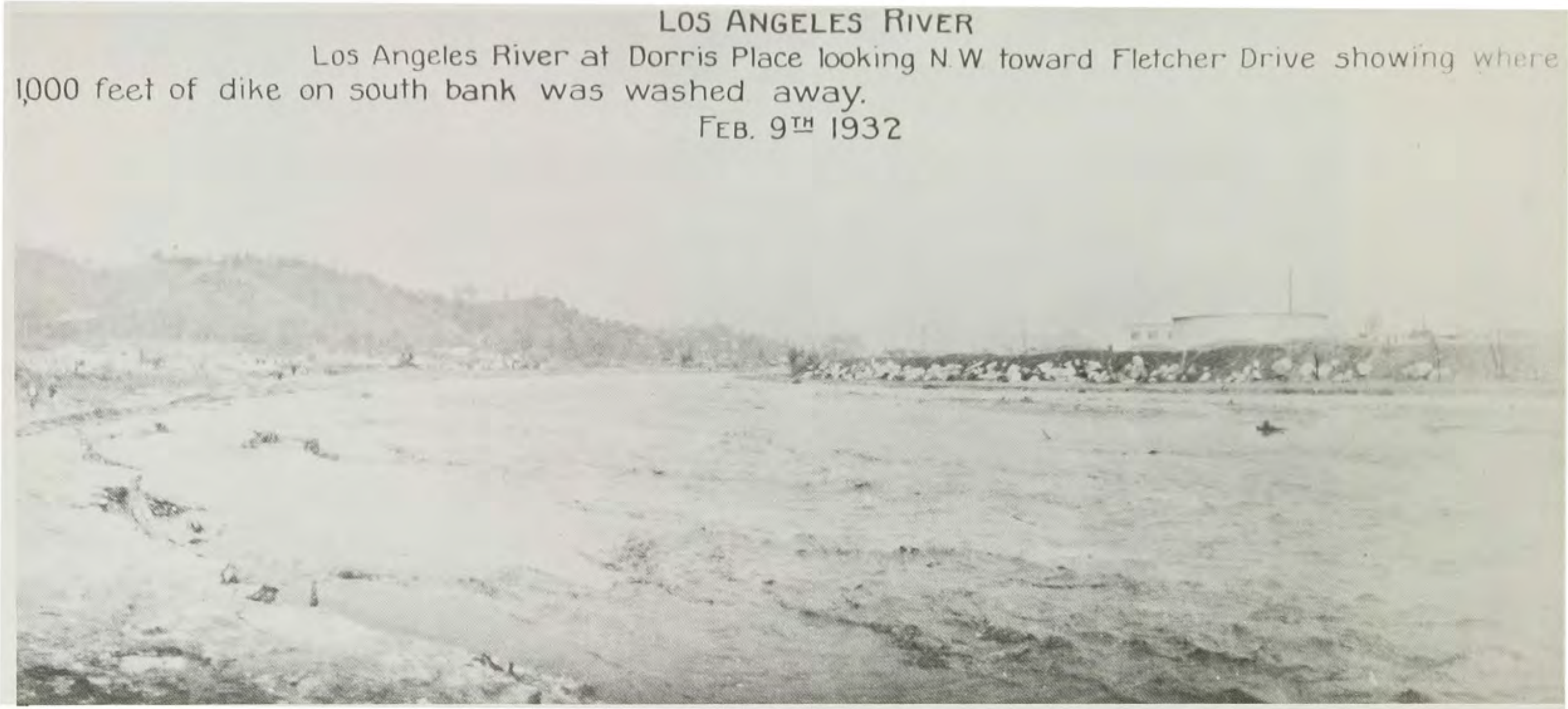
The Los Angeles River at Pacific Electric, Santa Ana Line, southeast of Lynwood, January 26, 1914 (Mile 10.2). A second and larger flood occurred February 18, 1914. This flood assisted in the creation of the Los Angeles Flood Control District. (Courtesy LACFCD)

Flood of January 17, 1916. View of the Rio Hondo looking west along the Southern Pacific Railroad bridge about 3/10 of a mile above the confluence of the Los Angeles River and the Rio Hondo. The picture demonstrates the menace pile bridges pose to adjacent property during major floods. (LACFCD photo)

Flood of December 19, 1921. View of the Rio Hondo about 300 feet south of the Stewart and Grey Road, one mile above the confluence of the Los Angeles River and the Rio Hondo. (LACFCD photo)

Flood of April 8, 1926. Downstream view of the Los Angeles River at Mile 1.9. (LACFCD photo)

Flood of February 16, 1927. Los Angeles River at Pacific Electric Whittier Line, Mile 15.3. (LACFCD photo)



Flood of February 9, 1932. The streamflow of this flood was one fifth that of 1914. (LACFCD photo)

Flood of January 1, 1934. Photo taken on January 8, 1936, showing upstream view of Los Angeles between Glendale and Griffith Park. Riverside Drive at the left was damaged. (LACFCD photo)

Photo taken January 2, 1934, the day after the debris flow destroyed or damaged some 500 homes in the La Crescenta area. This view shows Montrose after the debris flow from Hall-Berkley Canyon. (Spence Air photos)

Photograph taken December 16, 1934, showing the La Crescenta delta cone area with the burned over area in the background. On January 1, 1934, the debris flow from these burned over mountain areas destroyed or damaged some 500 homes, and caused a loss of 42 lives and property damage estimated at $5,000,000. (Spence Air photos)

works. As an interested party, the Federal Government lent a helping hand when the District constructed the channel from the Dominguez Narrows to the ocean to by-pass the floodwaters of the Los Angeles River and so to eliminate silting of the harbor.

After 1916 a dry cycle occurred, interrupted by minor floods in 1921 and 1927 that resulted in combined damage of more than $1 million, which allowed LACFCD time to develop flood control plans. However, by 1930 as a result of the rapid urban and suburban development of the area that increased the runoff, it was apparent that flood control work must be accelerated. The Flood Control District initiated the development of a comprehensive plan for the area, with a pressing objective of reserving channel rights-of-way and reservoir sites from fast-moving developers.

Then came the flood of New Year's Day, 1934, in the La Crescenta-Montrose area with a loss of 41 lives and damages in excess of \$6 million. This disaster forcibly brought home the need for immediate Federal assistance to speed up the flood control program. This flood also illustrated the rapidity with which a disaster of this type could strike and disrupt the water supply, electricity, highways, and other utilities. Moreover, people caught in the path of the flood had no warning or intimation of its approach. This flood vividly demonstrated the precarious position of suburban developments in the foothill region, the destructive power of debris-laden water, and the enormous amount of debris which could be carried in a single flood confined to a small area. The necessity to control debris resulted in the adoption of the debris basin and rectangular-concrete channel type of protection which were immediately constructed in the La Crescenta-Montrose area.

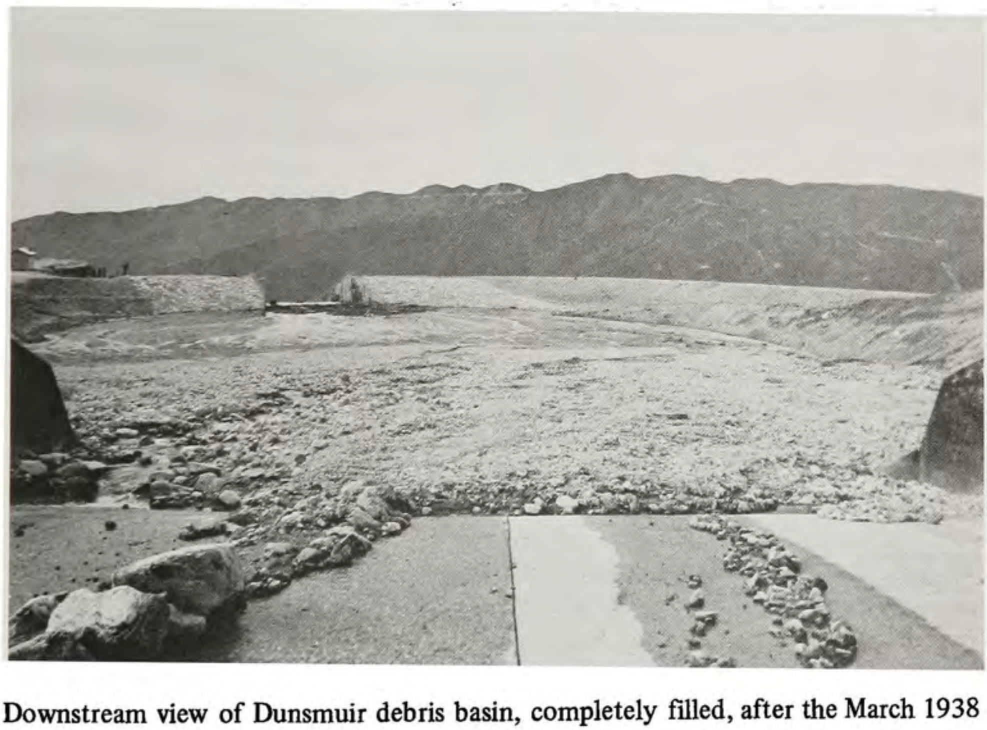
The Los Angeles County Flood Control District in its 1935 request for WPA funds submitted a comprehensive flood control plan. Upon review LAD deemed inadvisable for use the plans, surveys, and hydraulic designs, except for preliminary construction and checking purposes. This appraisal was not deprecatory of the work of LACFCD, since that agency was not equipped to present complete plans ready for construction. Actually, from the beginning, the two agencies, LAD and LACFCD, established a viable partnership. In 1 year, August 1935 to August 1936, over \$20 million was spent for the relief of unemployment with nearly 17,000 men at work, complete detailed plans were made, and the requirements of the various municipalities involved were met. No one would disagree with the judgment that no other large WPA contract in California was carried out with more dispatch, less unit cost, and achieved benefits than the one by LAD in Los Angeles County.

Then in 1936 Congress changed the mission of the Army Corps of Engineers from a temporary one to relieve the distress of an economic decline, to a permanent one with respect to flood control. Since 1936 the Army Corps of Engineers has been involved in the execution of Federal policy for nationwide flood control. Under the Flood Control Act of 1936 and subsequent acts LAD proceeded with preliminary examinations and surveys for flood control on important streams like the Colorado River above Lee Ferry, the Gila River and its tributaries in Arizona and New Mexico, the Los Angeles and San Gabriel Rivers, and the Santa Ana River. Other streams authorized for investigation included practically all those which drained into the Pacific Ocean from the Mexican border to the northern limit of the District near San Luis Obispo, some of those which drained interior desert areas, like the Mojave River Basin and the Coachella and Imperial Valleys, and some of the streams which drained areas in Colorado, Utah, and Nevada. These investigations frequently led to Congressional authorization for flood control construction.

Debris left in Dunsmuir Canyon by the 1934 Flood, which destroyed the east half of the check dam.

Granite boulder, about 9 feet in diameter, washed onto the pavement at the end of New York Ave. Dunsmuir Canyon flood of January 1, 1934.

House on east side of flood channel between Prospect Ave. and Evelyn St. damaged by flood water and debris (Jan. 1, 1934).



Downstream view of Dunsmuir debris basin, completely filled, after the March 1938 flood.

Before Congress appropriates funds for the actual construction of flood control projects, it requires economic justification as well as the saving of lives. The LACDA project, which will be further elaborated on, more than satisfied that Congressional requirement. In 1959 Colonel C. T. Newton, District Engineer, stated that in the 1930's the comprehensive analysis of costs and benefits for the LACDA project established a theoretical ratio of benefit to cost of 1.52; however, because of an expanded plan, growth of the Los Angeles area, increased property values, and with allowance for increased costs the actual benefit-cost ratio rose to 3.60.

Under authorization of the Flood Control Act of 1936, Major Wyman, in December 1936, submitted a definite project report for control of the Los Angeles River, and in February 1938 a general plan for the Rio Hondo and the San Gabriel Rivers. Ultimately these plans became the basis for the Los Angeles County Drainage Area project.

Further impetus to development of the flood control program for Los Angeles County came from the flood of March 2, 1938, which caused more than $40 million in damage and took a toll of 49 lives. The City of Los Angeles endured a 2-day nightmare in which the breakdown of rail, telephone, highway, and mail services left the city with the radio as the sole means of communication with the outside world. Over an emergency national radio hook-up, Mayor Frank L. Shaw with typical optimism reassured the world that: "The sun is shining over southern California today and . . . Los Angeles is still smiling."

To LAD engineers, the 1938 flood provided an excellent case study. More data were obtained on rainfall, flood discharges, and debris movement than had been obtained from any previous flood. Engineers observed the action of various flood control structures under the extreme condition of a major flood. A major result of experiences gained from the 1934 and 1938 floods was marked progress in engineering knowledge of the problems of flood control. Thus engineers secured invaluable information on the collection and analysis of hydrologic data, extended their knowledge of the design of structures capable of withstanding the destructive onslaught of major floods, and learned more about methods of protection against the movement of debris. The 1938 flood also graphically showed that areas that had not been burned over in many years could produce as enormous a debris load as that attributed to the burnt-over drainage area in the 1934 flood. The ineffective and dangerous practices of building mountain reservoirs and small, inexpensive check dams were also brought out. On the latter point current thinking by engineers is not as conclusive, which means that the little dam versus the big dam debate continues.

3 L. A. flood-control dams recommended

Construction sought to end perils

Tujunga Dam Checks Flood

NEW PROJECTS SAVED HEAVY DAMAGE HERE

Perfect Functioning of Dams Prevented Greater Losses, U. S. Army Engineer Declares

DEBRIS BASINS CURTAIL ALTADENA AND PASADENA LOSS TO PROPERTY ONLY

FLOOD PROJECTS AVERT DAMAGE

60 Millions of Control Works Keep Waters Within Bounds

FLOOD CONTROL WORK'S VALUE PROVED IN STORM SAYS SUPERVISOR LEGG

The Lookout

Mopping Up

Our well-known-and-justly-celebrated sun, after being A.W.O.L. for nearly a week, returned somewhat bashfully yesterday to find us a little bedraggled of tail-feathers and damp underfoot but otherwise rapidly recovering from the flood's effects.

This five-day, ten-inch rainstorm has been correctly called the worst, as regards physical damage, in twenty-five years. But, save for the lessons learned and acted upon after the disastrous floods of 1913-14, it would have been the worst in fifty-four years. Not since the winter of 1883-84, when it rained every day for forty-one days, has as much water fallen in as short a time as in the past week. Large as it is, the damage is so much less than it would have been but for our magnificent system of flood-control dams that we may consider ourselves to have come through relatively unscathed. People who have grumbled at the enormous cost of our flood-protection works might profitably compare it with the cost of what would certainly have happened here Wednesday but for those sturdy guardians of the Los Angeles basin. The long chain of dams above the San Fernando and San Gabriel valleys much more than paid for themselves in that one day, with all the money wasted and grafted thrown in.

This is not to say that we should be satisfied with our protective system or assume that all has been done than can be done to minimize the effects of our periodic floods. [illegible]

SMALL LOSSES PROVE VALUE OF DAM SYSTEM

Huge Amounts of Water Stored and Damage Held to Minimum

Los Angeles county's $50,000,000 investment in its vast flood control system paid large dividends in the form of prevention of tremendous losses that would have occurred in life and property if there had been no flood control system.

Such was the conclusion of engineers yesterday as they surveyed the results of the five-day storm that poured more than ten inches of rain down on Los Angeles.

The story of what the flood control system did is principally told in the fact that behind [illegible] fourteen flood control dams [illegible] of them perched high in the mountains, there was enough water being held to cover 106,336 acres a foot deep.

DAMAGE AVERTED

Had all that water come down on the valley along with the run-off that could not be captured or had to be released gradually, the damage seen in many quarters would have been far greater and areas that escaped damage would have suffered greatly.

Haggard and worn after working without sleep since the storm broke last Sunday, C. H. Howell, chief flood control engineer, said the flood control system functioned very well.

UNFORTUNATELY, however, we are almost completely devoid of a corresponding ability to get essential things done during "normal" times.

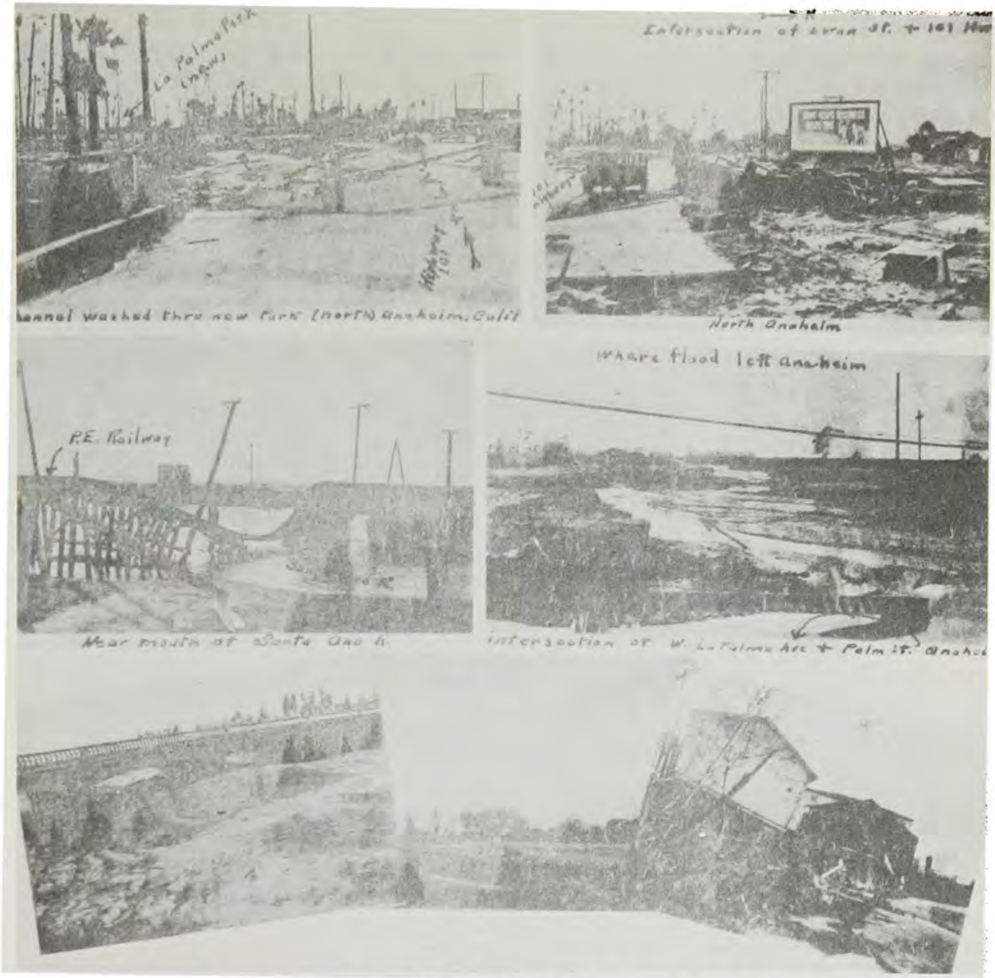
This is due, in large part, to the nature of democracy itself. We wait until an earthquake occurs before we make our schools earthquake-proof, and we prosecute our flood control programs after, rather than before, a flood has occurred.

Had it not been for the disastrous floods of 1933-34, for instance, it is doubtful if the vast flood control work completed only a few months ago, and which alone averted a horrible major disaster during the last 72 hours, would even have been started.

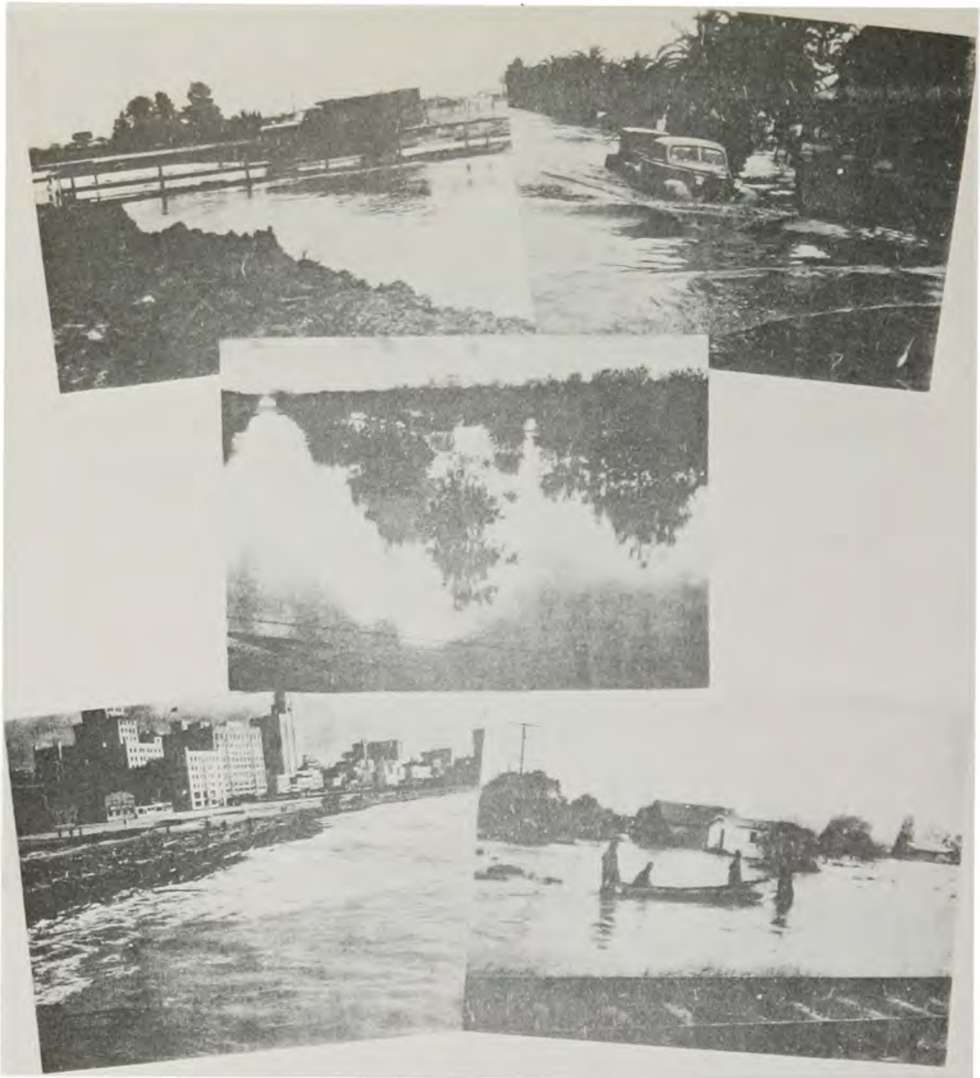
Page of newspaper clippings records the value of flood control. (*Safety Sun,* March 15, 1938)

BALLONA CREEK: (1) AT HAUSER BLVD. (2) DOWNSTREAM FROM WASHINGTON STREET BRIDGE. (3) HIGUERA STREET INLET. (4) WASHINGTON STREET LOOKING TOWARDS CULVER CITY. (5) VENICE, CALIFORNIA NOT ITALY. (6) STREET UNDERMINED AT WASHINGTON STREET BRIDGE APPROACH. (7) FLOODED STREET AT CULVER CITY. (8) PLAYA DEL REY NEAR WHERE BALL-ONA EMPTIES INTO THE PACIFIC.

Page of flood pictures for March storm of 1938.



Page of photos from *Safety Sun,* March 15, 1938. Orange County, hard hit by the flood, is pictured here at Anaheim, where the Santa Ana River took a terrible toll of life and property. The LAD flood control program had not progressed further than drilling for dam sites.



PHOTOGRAPH (UPPER LEFT) SHOWS THE COMPTON CREEK CHANNEL WITH FLOODING OF SMALL BRIDGE AWASH. UPPER RIGHT PICTURE WAS TAKEN AT OLIVE AND WILLOWBROOK. THE CENTER PHOTOGRAPH SHOWS AN ORANGE GROVE THAT PROBABLY WILL NEED NO FURTHER IRRIGATION THIS SEASON. LOWER LEFT PHOTO SHOWS DEBRIS ON THE BEACH AT LONG BEACH. DRIFTWOOD COVERED THE OCEAN BEACH FOR SEVERAL MILES ON EITHER SIDE OF THE LOS ANGELES RIVER MOUTH WHICH EMPTIES INTO THE PACIFIC AT LONG BEACH. THE LOWER RIGHT PHOTOGRAPH SHOWS A CANOE RESCUE AT COMPTON.

Photos with captions from the *Safety Sun,* March 15, 1938.

Upstream view of Los Angeles River Channel upstream from Soto St. bridge during flood of March 1938, which transformed a trickling stream into a raging, destructive torrent.

March 1938 flood wreaks havoc with railroad communication.

As well as an increase in engineering knowledge, the general public and public officials were emphatically educated in the problems of flood control. LAD indicted city planning for failures to resist encroachments upon natural channels and overflow lands. While engineers were aware of the need for flood plain management by 1939, they were unable to alter urban development which by its general disruption of the physiographic (ecological) balance not only increased the magnitude and destructiveness of floods but also intensified already difficult problems for the hard-pressed flood control engineers.

Another lesson provided by flood disasters, which also was applicable to all other types of disaster, was the need for a permanent disaster organization which would permit an efficient control of manpower, materials, and equipment in cases of emergency. Reliance on volunteers was outmoded. Definite plans for disaster control including an emergency organization began as a result of the 1938 flood to cope with sightseers and looters, as well as to provide emergency aid.

Out of the above experience came the existing Federal comprehensive plan for the Los Angeles County Drainage Area which was authorized by Congress in response to the report submitted by Lieutenant Colonel Edward C. Kelton, District Engineer, in 1940.

The crises in world affairs which began in the 1930's created a new aspect of flood control – its importance to national defense. As Colonel Warren T. Hannum, Division Engineer, South Pacific Division, stated at the meeting of the National Resources Committee, Los Angeles, March 1, 1941: "The necessity of solving these problems (the control of destructive floods) in addition to protecting lives and property increases very appreciably the justification of flood control in the areas where national defense industries are located." While flood control problems existed throughout southern California, the emphasis by LAD would be on the three population centers where national defense industries were concentrated – Los Angeles, Santa Ana Basin, and San Diego.

Through close cooperative planning between the Los Angeles County Flood Control District and LAD the basic premises of the original comprehensive plan for the Los Angeles County Drainage Area were carried out by 1966. Colonel C. T. Newton, District Engineer, and Harold E. Hedger, retired Chief Engineer, Los Angeles County Flood Control District, in a joint paper delivered before the Los Angeles Convention, American Society of Civil Engineers, 9-13 February 1959, summarized the results of the vast undertaking and publicized an outstanding example of close cooperation and participation among local, State, and Federal agencies in a common cause – the remarkable flood control project to protect Los Angeles County.

Flood of January 15-18, 1952. Floodwaters from Pacoima Wash in business section of Van Nuys, Calif., Los Angeles River Basin, upstream from Tujunga Wash.

Destruction of the Beverly Blvd. crossing on the San Gabriel River, Calif. (Flood of January 15-18, 1952.)

Flood of January 1956. Lower Los Angeles River viewed from the old Pacific Electric Railway Bridge at Carson Street looking southwest, downstream, toward upstream end of completed channel improvement.

Flood of Jan. 26, 1956. Flooded intersection (Earlmar Ave., Patricia Ave., Queensbury Rd., and Manning Ave.) Sawtelle-Westwood area. Note house on the right of which the lower floor is almost completely under water. The small object on the extreme right is the top of a lamp post.

Two major cooperating agencies, LAD and LACFCD, agreed upon a basic approach in the late 1930's, which included the following as summarized by Colonel Newton in 1959:

"a. Establish a series of basins to collect the mud-and-rock-flow debris at the canyon mouths of tributary streams in mountains' foothills.

b. Build flood control basins in the upper reaches of the main drainage systems to contain peak discharge and regulate downstream flow.

c. Rectify and stabilize the natural channels throughout the entire coastal plain for rapid drainage."

As a basis for design, engineers formulated the critical hydrological factors that would cause the hypothetical "Standard Project Flood" and the "Maximum Probable Flood." The former, Colonel Newton defined, "as the flood that would result if the maximum storm of record should occur over the project drainage area when hydrologic conditions were seasonably favorable for flood runoff." The latter type he defined "as the flood that would result if the maximum possible precipitation for the drainage area were to occur at a time when ground conditions are conducive to maximum runoff." Present criteria, by methods of transposition and with considerations to type of topography and storm, are based on the great storm of March 1938, a severe 3-day storm of late January 1943 centered in the San Gabriel Mountains, and a 3-day thunderstorm of March 3, 1943.

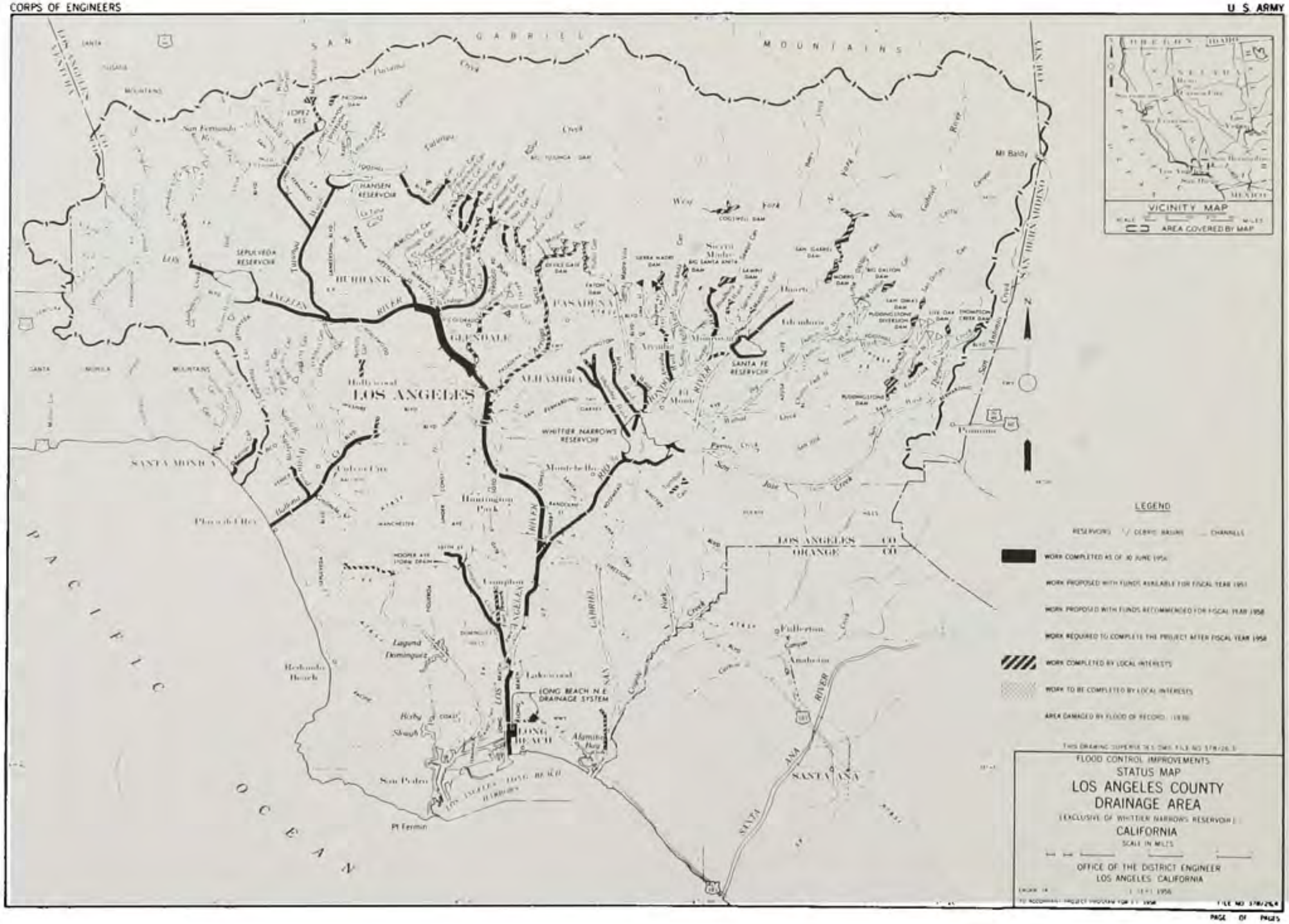
Since 1935 the annual efforts of LAD and local agencies have barely kept pace in providing necessary flood control works to protect the momentous growth of population and industry in southern California.

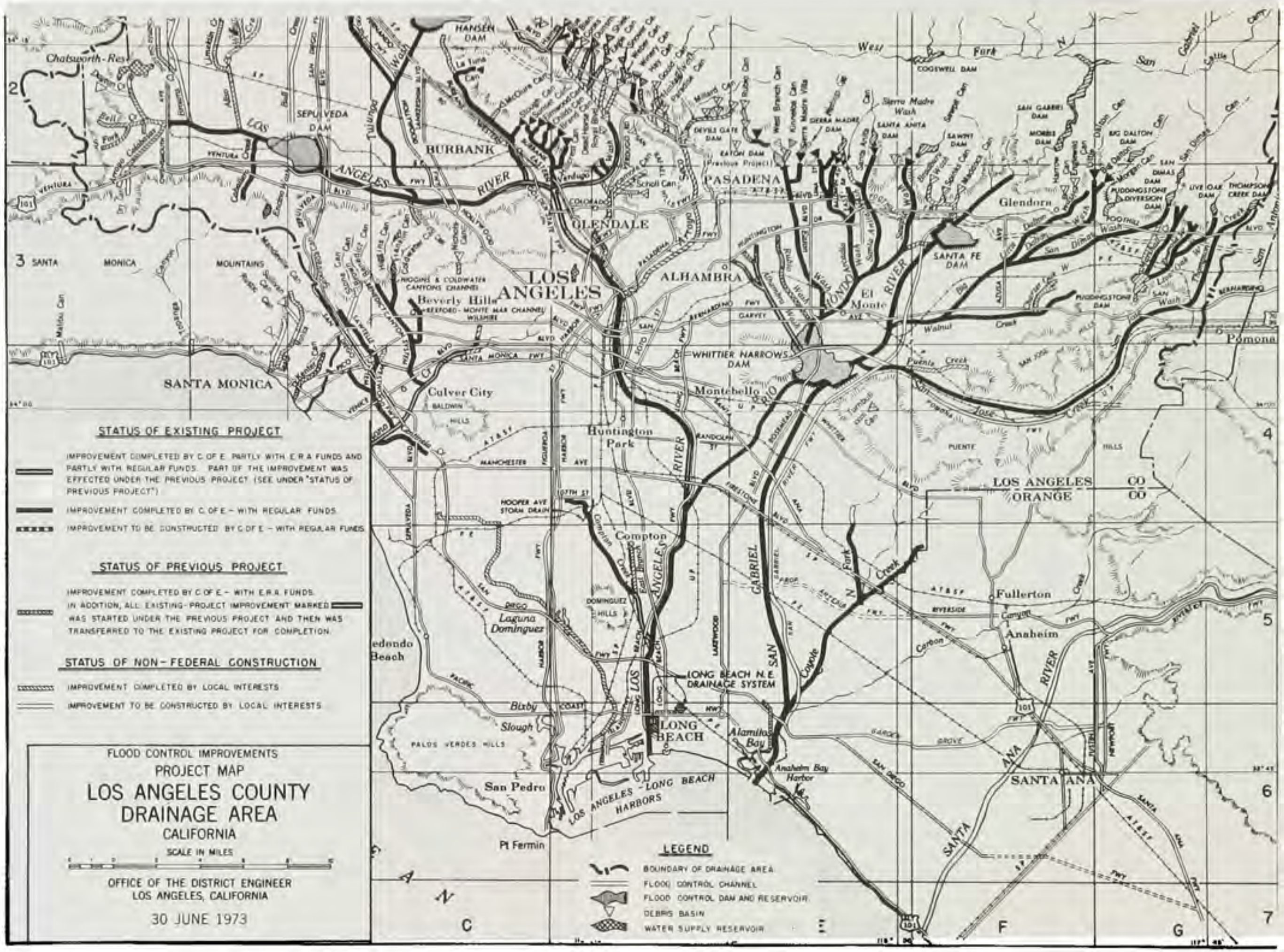
Prior to 1935 the three basic stream patterns – Los Angeles River, San Gabriel River and Rio Hondo, and Ballona Creek – draining the Los Angeles area followed meandering natural water courses. Between 1919 and 1921 the lower Los Angeles River was realined to divert floodflows from the Los Angeles and Long Beach Harbors. When funds became available under the Federal program of flood control, LAD directed its primary attention to the Los Angeles River which led to improvement of the channel from the southerly city limits upstream to the vicinity of San Fernando Valley. Ballona Creek, one of the many former channels of the Los Angeles River, also received improvement during this early stage of the program. Then emphasis for a few years was placed upon getting Hansen, Sepulveda, Santa Fe and Whittier Narrows Dams constructed.

Flood control in the Los Angeles County Drainage Area. This relief map graphically illustrates the flood problems of metropolitan Los Angeles, March 1939.

After the temporary delay of the Korean War, by concentration of the Los Angeles River channel improvement, the engineers stabilized the main channel from Canoga Park in the upper western end of San Fernando Valley to the Pacific Ocean in Long Beach. From 1957 construction work was concentrated on the tributaries of the San Gabriel River and Rio Hondo systems. The only Federal work in this program not completed is the reconstruction of the Sierra Madre Wash channel (0.7 miles long), which is stymied by an acrimonious dispute among local groups over the plan of improvement.

The LACDA project includes within the Los Angeles River Basin 17 debris basins on 53 miles of tributary streams, three major flood control basins (Sepulveda, Hansen, and Lopez), 48 miles of main channel control, and more than 100 bridges over main and tributary channels. Within the San Gabriel River and Rio Hondo Basins, 14 debris basins,


CORPS OF ENGINEERS
U. S. ARMY
SAN GABRIEL MOUNTAINS
PACIFIC OCEAN
LOS ANGELES
PASADENA
GLENDALE
BURBANK
ALHAMBRA
SANTA MONICA
LONG BEACH
SEPULVEDA RESERVOIR
HANSEN RESERVOIR
SANTA FE RESERVOIR
WHITTIER NARROWS RESERVOIR
LONG BEACH N.E. DRAINAGE SYSTEM
LOS ANGELES CO
ORANGE CO
VICINITY MAP
AREA COVERED BY MAP
LEGEND
RESERVOIRS
DEBRIS BASINS
CHANNELS
WORK COMPLETED AS OF 30 JUNE 1956
WORK PROPOSED WITH FUNDS AVAILABLE FOR FISCAL YEAR 1957
WORK PROPOSED WITH FUNDS RECOMMENDED FOR FISCAL YEAR 1958
WORK REQUIRED TO COMPLETE THE PROJECT AFTER FISCAL YEAR 1958
WORK COMPLETED BY LOCAL INTERESTS
WORK TO BE COMPLETED BY LOCAL INTERESTS
AREA DAMAGED BY FLOOD OF RECORD (1938)
FLOOD CONTROL IMPROVEMENTS
STATUS MAP
LOS ANGELES COUNTY
DRAINAGE AREA
(EXCLUSIVE OF WHITTIER NARROWS RESERVOIR)
CALIFORNIA
SCALE IN MILES
OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA
PAGE OF PAGES


FLOOD CONTROL IMPROVEMENTS
PROJECT MAP
LOS ANGELES COUNTY
DRAINAGE AREA
CALIFORNIA
SCALE IN MILES
OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA
30 JUNE 1973
STATUS OF EXISTING PROJECT
IMPROVEMENT COMPLETED BY C. OF E. PARTLY WITH E.R.A. FUNDS AND PARTLY WITH REGULAR FUNDS. PART OF THE IMPROVEMENT WAS EFFECTED UNDER THE PREVIOUS PROJECT (SEE UNDER "STATUS OF PREVIOUS PROJECT")
IMPROVEMENT COMPLETED BY C. OF E. – WITH REGULAR FUNDS
IMPROVEMENT TO BE CONSTRUCTED BY C. OF E. – WITH REGULAR FUNDS
STATUS OF PREVIOUS PROJECT
IMPROVEMENT COMPLETED BY C. OF E. – WITH E.R.A. FUNDS. IN ADDITION, ALL EXISTING-PROJECT IMPROVEMENT MARKED WAS STARTED UNDER THE PREVIOUS PROJECT AND THEN WAS TRANSFERRED TO THE EXISTING PROJECT FOR COMPLETION.
STATUS OF NON-FEDERAL CONSTRUCTION
IMPROVEMENT COMPLETED BY LOCAL INTERESTS
IMPROVEMENT TO BE CONSTRUCTED BY LOCAL INTERESTS
LEGEND
BOUNDARY OF DRAINAGE AREA
FLOOD CONTROL CHANNEL
FLOOD CONTROL DAM AND RESERVOIR
DEBRIS BASIN
WATER SUPPLY RESERVOIR
LOS ANGELES
BURBANK
GLENDALE
PASADENA
ALHAMBRA
SANTA MONICA
Beverly Hills
Culver City
Huntington Park
Compton
Montebello
El Monte
Glendora
Pomona
Fullerton
Anaheim
SANTA ANA
LONG BEACH
San Pedro
Pt Fermin
LOS ANGELES – LONG BEACH HARBORS
HANSEN DAM
SEPULVEDA DAM
SANTA FE DAM
WHITTIER NARROWS DAM
LONG BEACH N.E. DRAINAGE SYSTEM
LOS ANGELES CO
ORANGE CO
SANTA MONICA MOUNTAINS
PALOS VERDES HILLS

Proposed reconstruction of Sierra Madre Wash by local officials developed into a dispute among local groups.

two major flood control basins (Santa Fe and Whittier Narrows), 45 miles of main channel improvement, 104 miles of tributary channel work, and more than 200 bridges over main and tributary channels; and within the Ballona Creek Basin, two debris basins, 23 miles of main and tributary channels, 15 bridges over main channel, and two jetties at the mouth were built.

In 1958 Lee R. Henning, Special Assistant to the Chief, Engineering Division, LAD, recorded that since the Los Angeles River project began in 1936 with labor hired by the District, 14 contractors in 31 separate contracts had moved 20,000,000 cubic yards of earth, poured 2,025,000 cubic yards of concrete, using 3,450,000 barrels of cement, placed 147,350,000 pounds of reinforcing steel, and set 460,000 tons of grouted stone slope protection.

Henning, Ed Koehm, and others contrasted construction work prior to World War II and after on this project, particularly in concrete-channel lining. Before World War II all slope and invert paving was placed by hand methods. Concrete was hand screed and finished, which enabled a contractor to complete about 200 linear feet of slope paving per day. After World War II mechanization replaced hand methods. Thus heavy weighted screeds operated off the end of a tag line superseded hand screeding. Variations of this method of screeding were utilized until 1954. In that year Guntert-Zimmerman (Stockton, California) introduced the first slip-form paver on the Rio Hondo Inlet Channel to Whittier Narrows Basin. This slip-form paver eliminated the need for headers and paved continuous strips up to 60 feet in width. By operating on rails, this early slip-form paver could be used either for invert or slope paving. To handle the low-flow section at the center of the channel, one added a "low-flow pan" to the bottom of the screed.

The first slip-form paver maintained grade control by mechanical activation of hydraulic jacks at each corner of the machine. From activation control by man the system improved to full automation, in which indicator arms contacted limit switches which, in turn, operated solenoid valves controlling the vertical movement of the jacks.

In July 1957 the Corps of Engineers utilized another mechanical marvel when Guntert-Zimmerman introduced the first slip-form paver to operate on crawlers. This crawler paver enjoyed certain advantages over the rail paver. Immediately it eliminated the need for rails. As significant was its maneuverability, for the crawler paver could either walk around obstacles such as bridge piers or turn around at the end of a strip of paving. A single paver accompanied by two dual-drum paving mixers handled up to 3,000 linear feet of 10-inch invert, 24 feet wide in a single day.

Sepulveda Dam affords protection against floods for considerable residential, urban, and commercial development in the communities of Van Nuys, North Hollywood, Sherman Oaks, and Studio City. (Photo taken c. 1965.)

Aerial view of middle branch of Tujunga Wash after flood of March 1938. This area now protected by Hansen Flood Control Basin.

Aerial view of Hansen Flood Control Basin, March 5, 1941.

Tujunga Wash Improvement, Beachy Ave. to Hansen Dam. This view shows the completed channel looking downstream from Hansen Flood Control Basin. "A" is the intake structure for Hansen spreading grounds, "C" is the Gila Oaks Blvd. bridge, and "D" marks San Fernando Blvd. and Southern Pacific RR bridges.

Lower Los Angeles River channel, 7th St. to Pacific Ocean. Levees in this section were rebuilt and raised. Completed 1953.

The Los Angeles River improvement project also required the solution of many design problems. To permit percolation of water into the ground in one section of the project, engineers developed an invert paving design. In 1955 the method adopted was the cobblestone invert paving one which paved the invert with a layer of cobblestone properly graded, approximately 30 inches in thickness, a size capable of resisting displacement by streamflows, yet permit percolation to the substrata.

Also in 1955 channel invert paving was placed with continuous reinforcing steel, which meant that the only construction joints were those formed at the end of the day's placement of concrete. The reinforcing steel continued through the joint.

Improvements also were made in the subdrainage system. The earliest system consisted of a series of 4-inch weep holes on 10-foot centers in the concrete invert slab with gravel underneath and about four rows of pipe surrounded by gravel and outletted into the channel at approximately 1,000-foot intervals. In 1946 a system of filter and drain material layers and perforated pipe with outlets into the channel was used. The final method called for a system of perforated pipes and drain filter materials under the invert slabs. These pipes, doublegated, emptied into manholes on approximately 500-foot centers. This system prevented silt entering the drainage system under the channel invert slab.

The Corps of Engineers designed its own concrete mix with a strength of never less than 3,000 pounds per square inch for this type of work. The Corps also used an air entraining agent in concrete for several years. To save construction time, prestressed or precast highway and railroad bridge members were used frequently. Thus many time-saving construction features were adopted.

Colonel Newton, in his joint paper with H. E. Hedger, explained the necessity for the design criteria adopted for the Los Angeles River. The steep slope of the coastal plain produced high-velocity runoff from both the mountain and valley regions. Thus, to protect the heavily developed industrial and residential areas, concrete-lined channels were designed to confine and control these high-velocity flows. To cope with the problems inherent in supercritical flow around curves, through bridges, and at confluences, LAD conducted a great amount of hydraulic-laboratory investigation to obtain proper design criteria. Rights-of-way limitations often made it necessary to introduce considerable curvature in channel alinement. Short-radius curves demanded superelevation of the channel bottom in order to maintain equilibrium in the flow. In the design of channels, consideration also was given to the use of both rectangular and trapezoidal cross sections. While trapezoidal channels usually were less costly to construct, they required

Flood of 1938 at the confluence of Coyote Creek and San Gabriel River.

The Rio Hondo during the flood of March 1938. (Spence Air photos)

Whittier Narrows Dam and Reservoir. Looking upstream, the Rio Hondo outlet works and channel center foreground and Whittier Narrows Dam in right middle. Water impounded came from storm in November 1966.

Upstream view of San Gabriel River shows the site of Santa Fe flood control basin prior to construction, January 13, 1939.

Santa Fe Dam and Reservoir on San Gabriel River, completed in 1949.

more rights-of-way, because of greater width and greater radius of curvature need. In addition, bridge costs were higher due to greater overall lengths. Acute design problems also resulted from the continual necessity to join smaller to larger channels. The retaining walls of the open rectangular-concrete channel sections were designed as L-type walls and constructed in pairs opposite each other with the wall bases forming the channel invert or abutting against the invert slab, depending on the channel width. These walls were designed for two limiting conditions, with the channel empty and the channel full.

Thus LAD and its partners added a considerable store of engineering knowledge to the design and construction of flood control channels in metropolitan areas.

Up to 1965 the Federal first cost of the Los Angeles County Drainage Area Project was estimated at $350,254,000. In addition, approximately $20,000,000 was spent under Federal Emergency Relief Administration authorizations prior to the authorization of the comprehensive plan. Local interests have spent an estimated $69,900,000 for lands, easements, rights-of-way, and highway and highway-bridge modifications. For supplemental flood control improvements local interests have expended $765,000,000 and allocated an additional $1,435,000,000 for completion of the supplemental program.

The effectiveness of the flood control system has been tested by each flood season, with the 1969 flood providing the strongest challenge. The system more than paid for itself by preventing more than $1.5 billion in flood damages and preventing the loss of many lives.

Because floods sometimes do not occur for a number of successive years, the question of the need for a flood control system is invariably raised. However, when the inevitable floods do occur, then public appreciation for the foresight of engineers is openly and gratefully manifested. For example, the late Frank G. Bonelli, of the Los Angeles County Board of Supervisors, emphasized in 1969 that: ". . . the overall flood control system prevented one of the worst catastrophes in the history of Los Angeles County."

Thus, visitors to southern California should not be astonished at the sight of the immense, rock-lined or concrete "dry rivers" – but admire the perspicacity of their builders. The early Spanish settlers probably would not recognize these "new" rivers, like the Los Angeles, but no doubt would appreciate the modifications.

Flood control districts wisely were formed in Orange, San Bernardino, Riverside, San Diego, Ventura, Santa Barbara, San Luis Obispo, and

Hand labor used over a quarter century ago to spread, screed, and finish concrete on the slope (1938).

Concrete work on the slope is now performed with a rail-supported paver and membrane curer. Rio Hondo channel (1958).

Upstream view of Los Angeles River channel above Butte St. bridge before improvement.

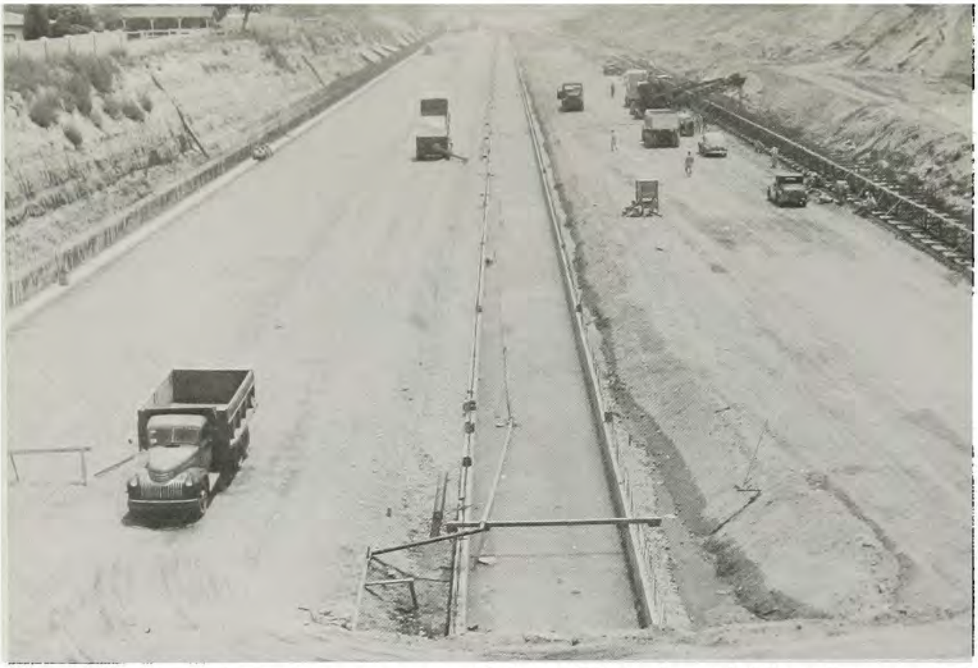
Completed Los Angeles River channel upstream from Butte St. bridge.

Upstream view of Los Angeles River channel above Soto St. bridge at start of construction.

Upstream view of completed Los Angeles River channel above Soto St. Bridge.

Slope grading, Lytle Creek.

Placing and compacting embankment fill on Sepulveda Dam.



Los Angeles River channel improvement, Tujunga Wash channel. View shows graded channel with wall footings on the left and low water channel complete. The forms and steel for the right wall footing are in place and concrete is being poured. To the left filter material is being dumped and spread preparing the invert sub-grade.

Placing stone blanket on upstream slope of Sepulveda Dam.

Grouting cobblestone.

Placing cobblestone between toes of levees.

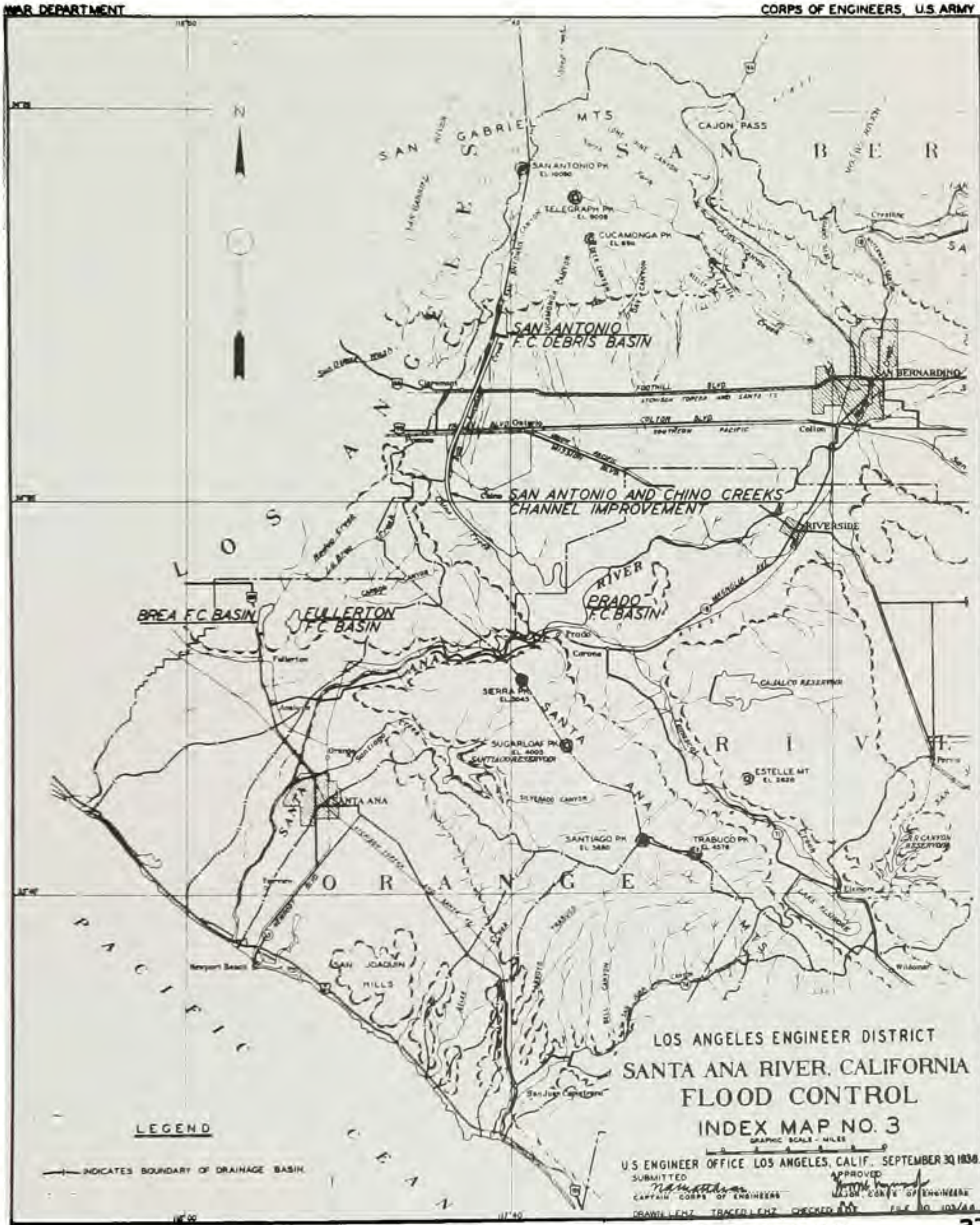
Imperial Counties, which also cooperated with the LAD to produce flood control programs that are still far from completion. Since 1938 numerous investigations and construction of flood control works have been and are being carried out in these counties. However, limited Federal funds in relation to the needs of the whole country have delayed the planning and construction of large debris basins, dams, levees, and concrete-lined channels that will protect these areas from flood devastation.

Among the areas within which considerable progress has been made is the Santa Ana River Basin which drains parts of four counties – Orange, San Bernardino, Riverside and Los Angeles – which meant that development had to be undertaken on a coordinated basin-wide program. Although LAD evolved a single, comprehensive plan for flood control, the District constructed the improvements outlined in the plan under two projects as authorized by Congress. The first, "Santa Ana River Basin and Orange County," provided for nine reservoirs and three levee and channel improvements and also incorporated the studies and reports of the Orange County Flood Control District, organized in 1929. These reservoirs were designed for multiple purpose usage. Also, in contrast to normal Corps policies, none of these improvements required local cooperation on costs.

Three of the dams authorized – Fullerton, Brea, and Prado – were designed, constructed, and placed in operation in 1941 and 1942. The activities of LAD on the other reservoirs were unavoidably spasmodic, as national efforts were concentrated on the prosecution of World War II. In 1950 the District again resumed preparations, only to suffer a setback by the Korean War. Finally, in 1955 Congress allocated funds for the Carbon Canyon Reservoir and Channel. LAD pushed this unit to completion in 1961.

In the meantime LAD constructed San Antonio Reservoir (1956) and San Antonio and Chino Creeks Channel (1960). Both the Carbon Canyon and San Antonio Dams differed from those authorized by Congress in 1938. After that time, considerable changes took place in southern California, which produced changes in the general design memorandum for these units. New hydrologic information relevant to the area had accumulated, based on important refinements in hydrologic methods. Geologists discovered that the original site for the San Antonio Dam was dangerously close to the active Cucamonga fault zone, obviously no place for a dam. The dam site was moved, the dam raised in height from 50 feet to 160 feet, and a side-channel spillway designed rather than a spillway in line with the river channel. The new studies produced changes which resulted in considerable savings in costs and better protection. Knowledge acquired from the planning and

construction of flood control works on the Los Angeles and San Gabriel Rivers also was applied. Yet the problem of design and construction paled in significance beside the difficulities of arriving at arrangements satisfactory to all concerned parties in the relocation of the various facilities in the reservoir and channel sites. In line with policies of the Corps large portions of the reservoir areas are being developed, or scheduled for development, for recreational purposes under leases to local governmental units.



Map of Santa Ana River Basin Flood Control Project, 1938.

37

Aerial view of mouth of Santa Ana River after flood of March 1938.

Aerial view of Anaheim, Calif., showing vast area of inundation from overflow of Santa Ana River during flood of March 1938.

Prado dam site after 1938 flood.

Road and railroad bridges along Santa Ana River destroyed by flood of March 1938.

Prado Dam at Santa Ana River mile 31.5, the major flood control work (1941).

Aerial view of Fullerton flood control basin (1941).

Damage from the March 1938 flood on San Antonio Creek.

Aerial view of completed San Antonio Dam (1956). Mount Baldy is in the background.

Carbon Canyon Dam, finished in 1961.

West channel of Lytle Creek at Colton, Calif., after the flood of March 1938, showing damage to transcontinental railroads and urban property.

From the upper end of the project, a view of the completed Lytle Creek Levee (1957).

The Orange County Flood Control District built the Villa Park Reservoir, but the Aliso, Trabuco and San Juan Reservoirs continued on the inactive list of LAD projects up to 1965 because of the lack of economic justification.

The second proposal, "Santa Ana River Basin," comprised four levee and channel improvements – Mill Creek levees, Riverside levees on the Santa Ana River; Devil, East Twin, and Warm Creeks channel improvements and Lytle Creek levee; and San Jacinto River levee and Bautista Creek channel. Local cooperation was required for these units, and they are maintained by the San Bernardino County Flood Control District.

Within Santa Barbara County LAD cooperated with the Santa Barbara County Flood Control District, the U.S. Bureau of Reclamation, and the U.S. Soil Conservation Service in joint approaches to the problems of flood control for the basins of Santa Maria and Santa Ynez Rivers and the south coastal area of the county.

Since 1937 both LAD and the U.S. Bureau of Reclamation had made studies of the basin of the Santa Maria River. To prevent any further duplication of efforts, the two agencies joined forces and produced a coordinated flood control and water conservation program to resolve the needs of the people in this basin. While the Bureau concentrated on water conservation studies, LAD made flood control analyses. The resulting plan recommended the construction of the Twitchell multipurpose reservoir and the Santa Maria Valley levee and channel improvements. The Bureau designed the Twitchell Reservoir, incorporating the prescriptions of LAD on flood control allocation and operation. LAD designed the Santa Maria Valley improvements. This cooperative effort went a long way toward meeting the flood control and water supply needs of the area.

LAD conducted studies of the flood control problems of the Santa Ynez River basin. Although the resultant plan called for levee and channel improvements along the Santa Ynez River in Lompoc Valley, LAD never reached the stage of recommending action to Congress, for local authorities did not indorse the suggested improvements because of complications involving rights-of-way. Thus this basin continues being plagued by floods during heavy rain storms.

Under authorization in the Flood Control Act of 1962, LAD initiated a study of the flood control problems along streams in the south coastal area of Santa Barbara County. The excellence of the presentation of these problems by the Santa Barbara County Flood Control District at a public hearing in April 1964 won the praise of Colonel Earl Peacock,

Upstream view of nearly completed Santa Maria Valley levee (December 1959).

District Engineer, as an example of the type of local interest and continuing participation by a local agency with LAD so essential to the timely efficient solution of flood problems.

Available historical records indicated that this coastal region had experienced many intense storms which resulted in floods of great magnitude and damage. An accelerated program of flood protection was necessary, for in the flood hazard area an explosive growth of population and development had taken place since 1950. The LAD studies also would be coordinated with those of another Federal agency, the U.S. Soil Conservation Service. In spite of the urgency, the district engineer warned that any recommended improvements would require authorization by Congress. To 1966 progress beyond the planning stage had not occurred.

In contrast to Los Angeles County, no comprehensive study by LAD had been made of the flood control needs of San Diego County. However, reports were prepared on the San Diego, Sweetwater, San Luis Rey, Tia Juana and San Dieguito Rivers. By 1965 suburban development and growth of population, both those taking place and those forecast, along these streams as well as recognition of similar expansion in other parts of the county warranted consideration for a comprehensive flood study. In the meantime, Federal construction of the authorized San Diego River and Mission Bay project, a combined small-craft navigation and flood control effort, was completed except for the correction of a surge problem in Quivira basin. As a result one of the most satisfying vacation complexes in the world came into existence.

Some protection for Ventura County was provided by LAD with the construction of levees on the Santa Clara and Ventura Rivers, but growth again establishes the need for a high priority study of continuing flood problems.

Southern California is not the only area within the District threatened by floods. The entire Colorado River drainage basin, encompassing southeastern California, southeastern Nevada, southern and eastern Utah, southwestern Wyoming, western Colorado, western New Mexico and Arizona, is an area of responsibility for LAD, not just for flood control but for all activities related to water resources. One constant concern of district engineers was and is to report on activities of LAD in the above areas to public officials and interested private organizations.

Within the Colorado River basin several projects were designed to provide flood protection for both Arizona and California areas. Typical major multipurpose projects are the Hoover Dam, constructed by the Bureau of Reclamation, and the Corps of Engineers Painted Rock Dam on the Gila River, and Alamo Dam on the Bill Williams River in Arizona.

San Diego River Dike, Jan. 20, 1897. Repair work of raising crest and revetting face with riprap nearly completed.

Flood of January 1916. Probably the most devastating flood to hit the San Diego area.

Flood condition near the Consolidated Aircraft Corp. plant in San Diego, March 14, 1941.

Santa Clara River on a rampage damaged Southern Pacific Railroad during March 1938 Flood.

Santa Clara River levee. View of nearly completed levee looking downstream from the upper end of the project (1960).

Construction on Tijuana Dam, Mexico, for the International Boundary and Water Commission (1968).

Another project is an authorized investigation for the entire Virgin River basin, which is a part of the Colorado River basin, and includes portions of southern Nevada and Utah, with the completion date indefinite. Prior to this authorization local interests in the basin proposed 82 projects, the bulk of them in southern Utah, but none of the projects were justified according to the district engineer. However, within the basin LAD completed in December 1957 interdependent reservoirs in Pine and Matthew Canyons, which protect a large area along Clover Creek, Meadow Valley Wash, and the lower Muddy River. The preliminary examination report in which the District Engineer recommended these improvements is dated July 15, 1939, which demonstrates a typical time lag created by lack of funds.

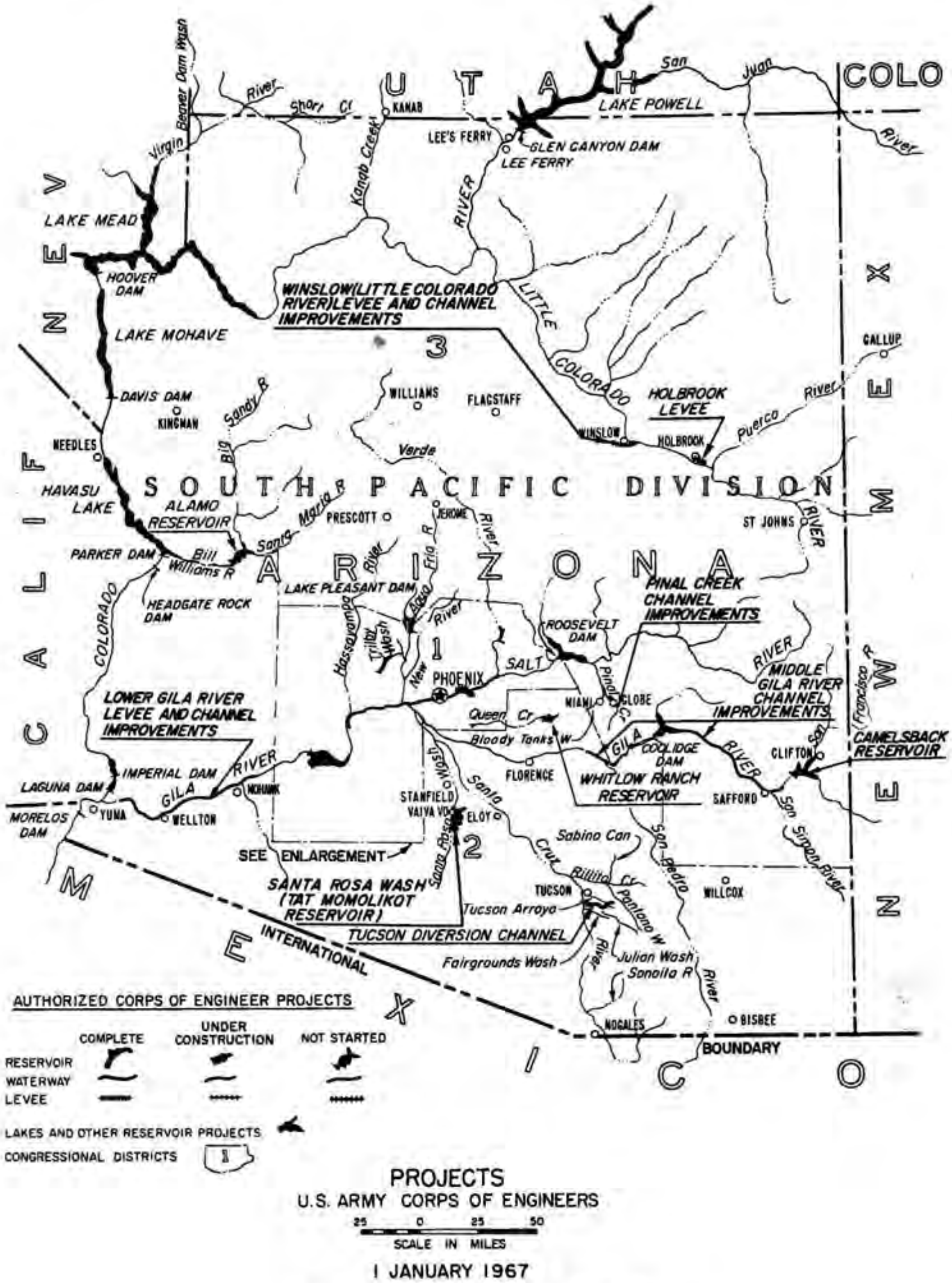
The growth of the metropolitan region of Las Vegas, Clark County, Nevada, has accentuated the flood control problem there. Providing for the security of the Las Vegas area against floods has been difficult. An authorized Federal project for diversion levees, detention basins, and outlet channels on tributaries of Las Vegas Wash was classified as inactive in February 1964 because local authorities failed to obtain approval of a local bond issue to provide funds for congressionally required local cooperation.

As a valid alternative the Clark County Flood Control District has obtained flood plain information studies from LAD that provide guidelines to plan proper development in these flood plains. The entire incident illustrates the principle that local interests control what is ultimately done by the Corps and this makes the resolution of problems difficult.

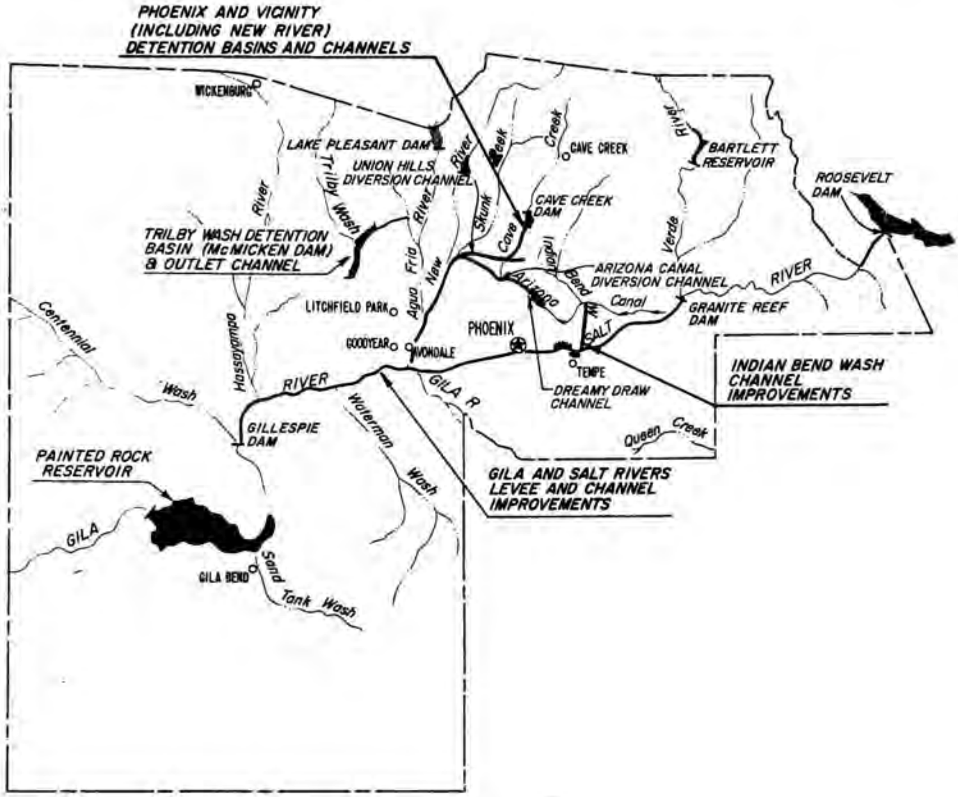
Heavy winter rains plague Arizona to a greater degree than southern California. The transformation of Arizona from a barren wasteland to a wealthy, highly developed urban, industrial, and agricultural area has caused considerable expansion of the civil works function of LAD to protect the new development from destructive floodwaters.

Of the 15 flood control and multipurpose projects authorized in Arizona, six have been completed. Two, the Alamo and Painted Rock Reservoirs, are important units within the overall flood control plan for the lower Colorado River drainage area, a plan formulated as a result of studies authorized in 1944.

The Alamo Reservoir on the Bill Williams River will help protect against floods about 230,000 acres of land along the Colorado River from Parker Dam to the Mexican boundary. In addition, the water-conservation feature will provide substantial irrigation benefits and recreational facilities. By reducing the sediment inflow into Havasu Lake, the project will enhance the development around that lake.



Projects Map, Arizona (1967).

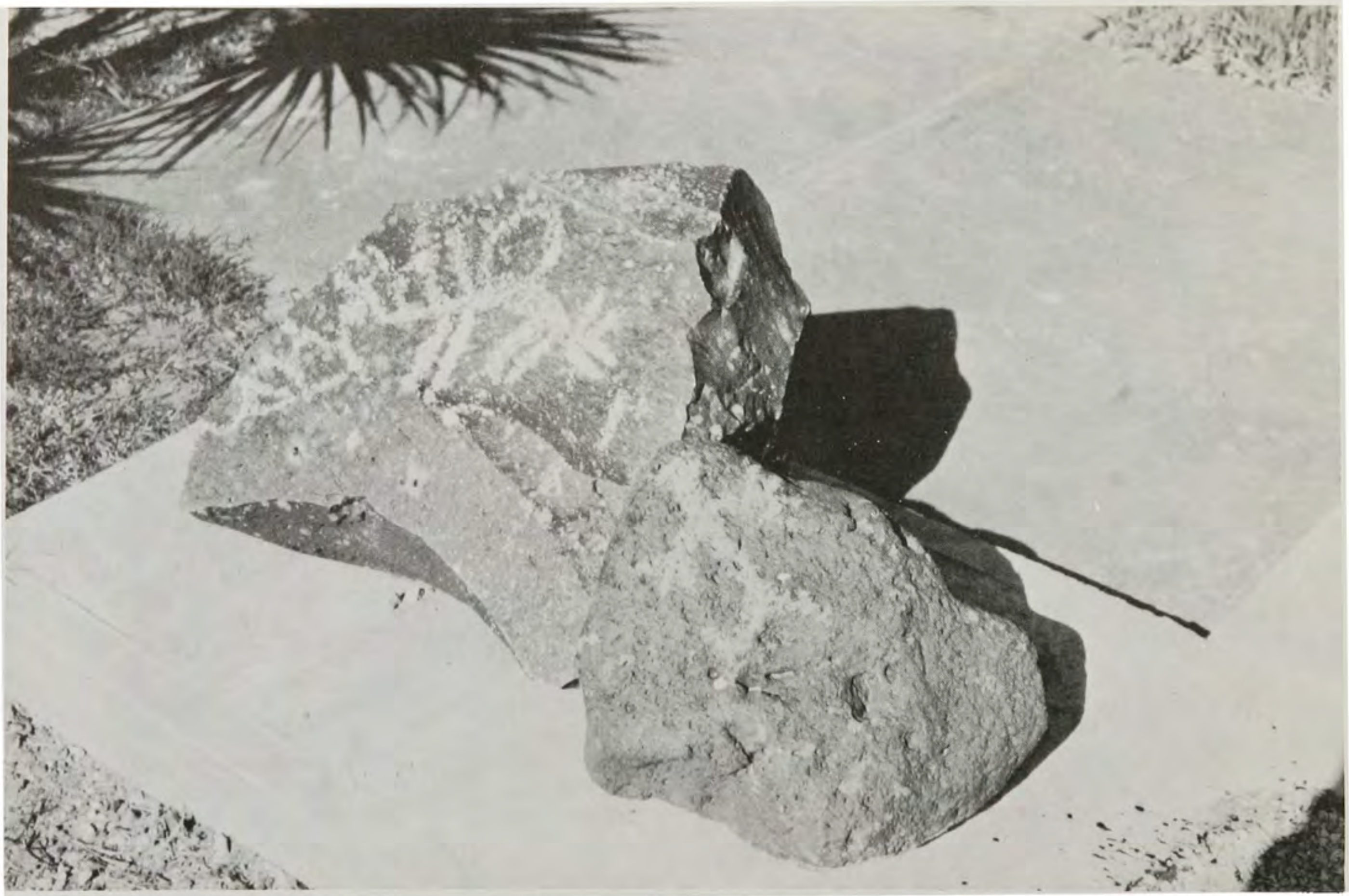


ENLARGEMENT OF MARICOPA COUNTY

SCALE IN MILES

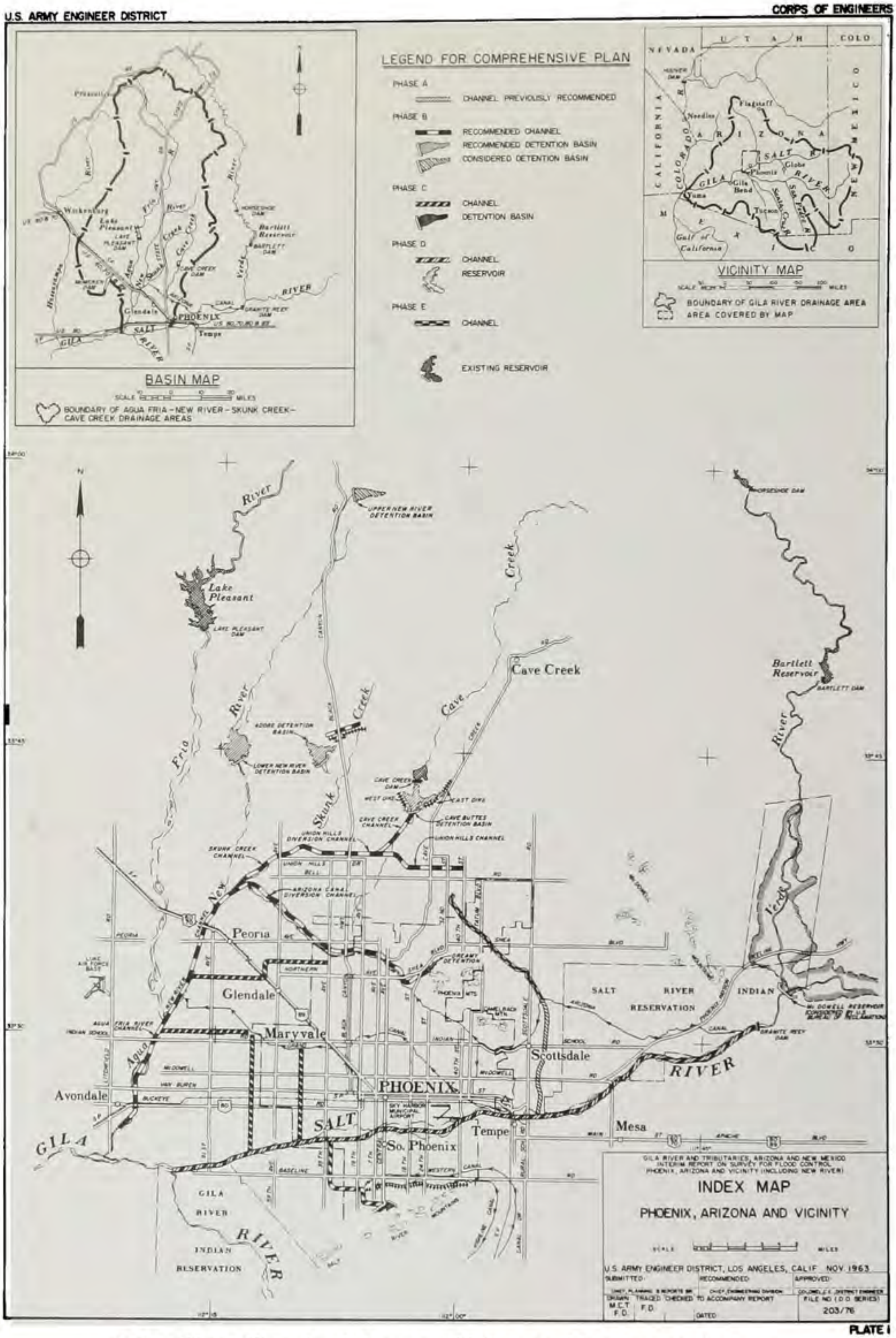
Alamo Reservoir, Bill Williams River, Arizona. View showing administration area under construction (1963).

Painted Rock Dam, Gila River Basin, Arizona. Aerial view of project completed in 1959.



Painted rocks, Indian petroglyphs, after which site was named.

Flood Zones and Probable Overflow Area from floods in the Little Colorado River, Holbrook, Arizona (1940).



Index Map, Phoenix, Arizona and Vicinity. Flood control plans.

McMicken Dam, Arizona, is almost 10 miles long.

Whitlow Ranch Reservoir, Queen Creek, Arizona (1960).

View of proposed Tucson diversion Channel with Part One in solid lines (1963).

Painted Rock Reservoir is shaped by a dam across the Gila River in Maricopa County, Arizona, about 100 road miles southwest of Phoenix. The project protects against floods 300,000 acres of agricultural lands along the Gila River downstream from the dam, and along the lower Colorado River not only in Arizona but also in California, including Imperial Valley. Flood protection also is furnished to residential, commercial, and industrial properties in the City of Yuma and small towns nearby, to extensive irrigation facilities, to transportation facilities, and to vital defense installations. In addition, the reservoir will implement the functioning of the 1944 Water Treaty with Mexico. Among the historical highlights of the locale is the very interesting Indian Painted Rock petroglyph site, from which the dam derives its name.

Besides the above multipurpose works, LAD has constructed several other flood control works. The Holbrook levee, completed in December 1948, along the north bank of the Little Colorado River at Holbrook, protects about 95 percent of the city from floods. To protect Luke Air Force Base, Phoenix Litchfield Municipal Airport, industrial plants, and the towns of Goodyear, Litchfield Park, and Avondale, and agricultural land, LAD built McMicken Dam, the Trilby Wash detention basin and a leveed outlet channel.

The Tucson diversion channel, completed in April 1966, prevents floodwaters from devastating urban areas in the downstream part of the Tucson Arroyo drainage area, and along Julian Wash.

About 40 miles southeast of Phoenix, the District completed in November 1960 the Whitlow Ranch Reservoir, primarily for flood protection to about 142,000 acres of valuable agricultural land. The reservoir and dam also demonstrated another value of a flood control dam, as each year retardation of floodflows permits the percolation of about 16,000 acre-feet of additional water to recharge the underground storage basins along the channel.

Among the authorized multipurpose reservoir projects not yet started is an unusual one, the Santa Rosa Wash project, that will prove invaluable to Indians. Not only will the proposal provide the flood protection to agricultural lands, the towns of Stanfield and Maricopa, and several Indian villages, but also it will enhance life within the Papago Indian Reservation by increasing the water supply potential, delivering more water for irrigation purposes, improving hunting, fishing, and the recreation functions that attract tourists, and assisting in area redevelopment to ease underemployment for Indians.

Also authorized, but not under construction, is the Camelsback Reservoir, which will reduce flood damage in Safford Valley by about 75 percent. Levee and channel improvements on the Gila and Salt Rivers will provide complete protection against the standard project flood for most of the City of Tempe, portions of the City of Phoenix and other developed areas, and agricultural land along those rivers. To safeguard intensively developed residential areas along Indian Bend Wash in and adjacent to Scottsdale, Arizona, the Indian Bend Wash project was authorized by the 1965 Flood Control Act. Lower Gila River levee and channel improvements downstream from Painted Rock Reservoir and Middle Gila River channel improvements, from the upper end of Safford Valley to Buttes Reservoir site, are ready for construction except for assurance of necessary compliance for their share of costs by local interests.

Preconstruction planning is under way on a project to provide a high degree of protection against floods to urban and agricultural property within the metropolitan area of Phoenix.

A troublesome issue for LAD is the tremendous magnitude of the phreatophytic problem in the southwestern United States. When Seldon F. Cramer, Chief, Planning and Reports Branch, addressed a convention of the American Civil Engineers Society on April 11, 1961 at Phoenix, Arizona, he analyzed the scientific and engineering aspects of the problem. He reported that none of the early settlers who planted the original phreatophytes to serve as windbreaks and ornamentals "envisioned the hydra-headed monster they were spawning." He observed: "In addition to being great wasters of water, river-bottom phreatophytes choke normal flood channels, thereby decreasing their flood-carrying capacities and increasing overbank flooding." The prescience of the Corps is revealed in the work on phreatophytes of E. C. LaRue, a valuable member of LAD. Cramer remarked that LaRue studied this problem in the early 1930's and was one of the first in the southwest "to foresee that the water wasted by phreatophytes would someday be sought as an additional supply in some areas." In 1939 the Corps financed the pioneer investigation under the direction of S. F. Turner of the U.S. Geological Survey to determine the consumptive use of river-bottom growth in the Gila River Valley near Safford, Arizona. The results were embodied in an unpublished report on flood control, "Gila River above Salt River, Arizona, December 1, 1945." Other agencies also participated in similar research, which made the phreatophyte subcommittee of the Pacific Southwest Inter-Agency Committee one of the best informed groups on the subject.

As the action agency, LAD recommended in 1957 clearing about 94 miles of the Gila River channel from the head of the Safford Valley to Buttes damsite in Arizona. Although authorized by Congress in 1958, the project became enmeshed in an environmental dispute in the late 1960's, for the undesirable phreatophytes had become a prime wildlife habitat. Suddenly the engineers were faced by angry unreasonable wildlife enthusiasts. The District listened to all involved parties and produced a balanced plan which provides for flood control and protects to the maximum possible degree the natural vegetation to be made available for wildlife.

In addition to its concern for the completion of feasible and necessary flood control works, for the improvement of procedures for comprehensive and coordinated river basin programs, and for the maximization of the use of water resources, LAD has carried out the policies of Congress in areas like flood emergencies, especially the improvement of flood prediction and warning systems to reduce the destruction of lives and property, flood disaster relief, and flood plain management, the latter emphasizing less expensive alternatives for expensive flood control works.

Since the passage of the 1948 Flood Control Act, Congress permits the construction of small flood control projects and the performance of emergency work without time-consuming special congressional authorization. LAD and other districts may perform such work although not specifically authorized by Congress whenever the Chief of Engineers deems this work advisable. The project may not exceed \$1,000,000 in Federal costs, must constitute a complete solution to the problem involved and not commit the Federal Government to further improvements to insure effective operation.

Examples of these projects are the City Creek levee project, about 5.5 miles east of San Bernardino; the Banning levee project, and the Oro Grande Wash channel project in the City of Victorville, all in California.

The task of LAD does not end upon completion of a flood control project, for during emergencies the District is responsible for the proper functioning of the labyrinth of flood control structures and channels, the control of flood control dam gate settings, and downstream gage heights. On this informed basis volumes of flow from various control points are dispatched into the "main line" channels, thus routing the flood on down to the ocean with little or no damage.

Since 1938 the flood control system has functioned to prevent recurrence of flood damage and loss of life that occurred in previous

City Creek levee, a small flood control project in San Bernardino County, Calif., is at the right. The levee-like structure at the left is a spoil-bank area used for the disposal of excess channel-excavation material.

floods. The partially completed LACDA system controlled floods in 1941 and 1943 that otherwise would have caused considerable damage. Generally, within the Los Angeles District, flood damage and loss of lives have occurred where flood control structures were not available to control flows as happened during floods in the 1950's and 1960's.

It is doubtful that the flood control program of the Los Angeles District will ever end. This was the conclusion drawn by Simon Light of the Project Planning Branch in 1964. The growth of the population in southern California, Arizona and Nevada will further intensify the flood and related water problems in the Pacific Southwest. As District personnel have demonstrated, they stand ready to accept the role and responsibility, upon availability of funds, to produce studies to meet the growing needs of the area.

In spite of the success of the flood control program in the Los Angeles District, heavy rain storms still destroy lives and damage

property. These losses result not from the inadequacy in engineering flood control systems, but from the stubbornness of the human factor as man continues his unintelligent use of flood plains.

Back in the 1930's engineers of LAD urged wiser use of the flood plains by recommending that city planners resist attempts to encroach upon natural flood channels. They recommended that known overflow lands should not be used for building purposes, but be restricted to types of use which would not be materially impared by flooding. Not until the Flood Control Act of July 14, 1960 did Congress authorize the Corps to provide flood plain information studies to assist local governmental agencies in making better decisions about flood plain management.

Among the first to apply for assistance was Maricopa County, Arizona, one of the most rapidly growing areas in the southwestern United States. Similar requests for assistance came from local government agencies in and near other rapidly growing communities within the District. LAD made available to these agencies not only flood plain information reports but also technical services and guidance.

In addition LAD is urgently concerned with the preservation of open space, particularly in urban areas. By restoring and preserving the flood plains for use as open space, LAD hopes to improve the quality of the total environment for man as well as to permit him to live in harmony with his surroundings. To meet the needs for urban development and for the preservation of open space natural areas, LAD recommended the adoption of coordinated plans for regional development in which the multipurpose functions of flood plain lands would be considered.

Moreover, the District is cooperating in a long range statewide flood plain information program initiated by the State of California. Reiterating the basic philosophy of the Corps, Seldon F. Cramer warned that: "Implementation of flood plain regulations is strictly the responsibility of local government agencies."

In addition to its planning, construction and advisory roles the Los Angeles District holds a statutory floodfighting responsibility, the purpose of which is to assure effective functioning of flood control works during an emergency. Besides operating the flood operations center, the District executed rescue work, improvements of flood control structures, and maintenance of flood control works destroyed or threatened. To execute this mission, LAD established stand-by organizations and procedures which include the use of private

Imaginative Flood Plain Management combines preventive measures and normal protection of dams and channels.

construction firms and the support of other branches of the Armed Forces.

Emergency work is accomplished under Congressional authorizations of three types – emergency bank protection work; snagging and clearing work; floodfighting, repair, and rescue work.

Disaster relief by the Corps is not confined to flood disasters. It also includes, in the terminology of the Federal Disaster Act of 1950, any drought, fire, hurricane, storm or any catastrophe which in the eyes of the President is of sufficient severity and magnitude to warrant disaster assistance by the Federal Government when reasonable State and local efforts are not adequate. With its decentralized organization and "knowhow" gained from years of experience and its continuous pre-planning, the Corps is in a position to respond decisively and swiftly when disaster strikes. This response takes place at the request of the Office of Emergency Preparedness.

A few illustrations will demonstrate the effectiveness of LAD in performing emergency and disaster assistance work. Following the floods of December 1955-January 1956, the Corps of Engineers acted as an engineering and construction agency for the OEP for disaster recovery and rehabilitation in several flood-stricken areas. During the floods of February - June 1958, OEP utilized the Corps as an advisory agency, in particular to prepare evaluation reports for repayment of costs incurred by local government for rehabilitation work.

The Baldwin Hills dam failure of December 14, 1963 will illustrate how decisively and swiftly LAD functions when disaster strikes. On the afternoon of the above date the Baldwin Hills earthfill dam in Los Angeles failed, releasing 730 acre-feet of water on the residential, commercial, and industrial area lying between the dam and Ballona Creek. Fortunately, there was time to evacuate the area, which averted heavy loss of life.

The disaster triggered a series of actions leading to direct assistance by all levels of government.

Since the City of Los Angeles had exhausted its capability to clean up and rehabilitate the area, the city requested Federal aid. Thereupon, President Lyndon B. Johnson declared Los Angeles County a disaster area, making the area eligible for Federal aid through the Office of Emergency Planning. The OEP on the 24th of December then directed the Corps to undertake clean-up and restoration. Prior to that, a 10-man group from LAD had determined the limits of the flooded area and

Maps in Flood Operations Center show flood control projects in LAD. During a flood disaster, data on rainfall, streamflow, and reservoirs are inserted on the maps.

estimated damages to be $11,300,000, excluding those to the dam. On the 26th of December, OCE allotted fund authority in the amount of $1 million to LAD.

Under what had become standard routine for the Corps, Colonel Peacock, District Engineer, in anticipation of the order, made preliminary contacts to determine contractor capabilities. Under a letter-type contract the District engaged the services of Morrison-Knudsen. The work of clean-up and restoration was accomplished in two phases. In phase one the contractor did general clean-up work, involving not only the clearance of debris from public property, but also, where necessary, from private property to prevent public health and safety hazards. In the second phase the contractor rebuilt roads, sewers and drains, and performed other work to reestablish minimum public facilities. In addition, a buttress fill to stabilize a land mass undermined by floodwaters was constructed. This

Baldwin Hills Dam and Reservoir, looking downstream. Note break in dam and in asphalt lining along length of reservoir.

Downstream view of Cloverdale Avenue, showing typical damage to residential property after dam break.

Same view as previous photograph. Sidewalks, curbs, and gutters restored subsequent to Corps of Engineers work.

Basin from El Mirador near Veronica, looking northwest. Cleanup operations about two weeks after dam broke.

emergency restoration work was performed at a cost of $1,251,000. Other emergency funds were provided to the District for the rehabilitation of Ballona Creek flood control channel, damaged by the escaping water, debris, and sediment, because maintenance of the channel is a District responsibility. Repair and removal of debris was completed at a cost of $30,500. Removal of debris from the channel mouth was accomplished by dredging, at an estimated cost of $102,300. For this work, the Corps basked in favorable publicity.

Another excellent example of the capabilities of LAD occurred during the floods of November-December 1965 which caused serious damage in Riverside, San Bernardino, and Ventura Counties in southern California, and also in Maricopa County in Arizona. Throughout this period of two months of record or near-record precipitation the Hydraulic Operations Center remained on 24-hour duty, supervising flood control operations and controlling water release from dams designed for conservation purposes. While floodflows in southern California were easily contained by existing works, considerable damage resulted where no flood control structures existed. Other personnel of the District performed emergency and disaster assistance work in southern California and Arizona, which also produced public accolades.

Every disaster adds to the store of valuable experience which LAD utilizes in coping with emergencies. Sometimes a tragedy precipitates authorization. A good example is the catastrophe in Santa Barbara County produced by a fire which raged from September 22 through October 1, 1964, burning off 67,000 acres of valuable land. With the rainy season in the offing emergency work was required to reduce the hazards to life and property from anticipated flood and debris flows in the denuded areas, but there was no authorization to cope with this type of disaster. The 88th Congress reacted quickly and established a national precedent with passage of Public Law 635 authorizing the Corps to perform this type of emergency work. Swiftly LAD undertook corrective flood control work to control debris and channel flows to avert or lessen damage prior to actual occurrence of flooding. F. R. Cline, Chief, Design Branch, reported that the District personnel involved produced an efficient and economical method of remedial action to control debris flow. To contain large cobbles and boulders and permit the ashes, sand, and gravels to be flushed down the channels, they constructed small "boulder traps." The natural gap in grading of the mineral debris in this area of Santa Barbara led not only to the adoption of this very economical method in 1964-1965 but also to a precedent for future use in similar situations.

Since 1916 the Los Angeles District in cooperation with county flood control districts has made tremendous progress in its mission of preservation and promotion of public health and safety from disasters, especially floods. Unfortunately, as Brigadier General John A. B. Dillard, Division Engineer, South Pacific Division, related in 1966, people in the southwestern United States, with its burgeoning population, do not realize their need for flood protection until they undergo the painful lesson of personal experience. Besides public apathy, a lack of funds and the reluctance of local authorities to control development in flood plains and to provide funds for continuing maintenance of existing flood control works have handicapped the achievement of a viable system of flood control for the whole southwestern area of the United States.

CHAPTER VI

WATER RESOURCES: FROM SINGLE-PURPOSE TO MULTIPLE-PURPOSE PROJECTS

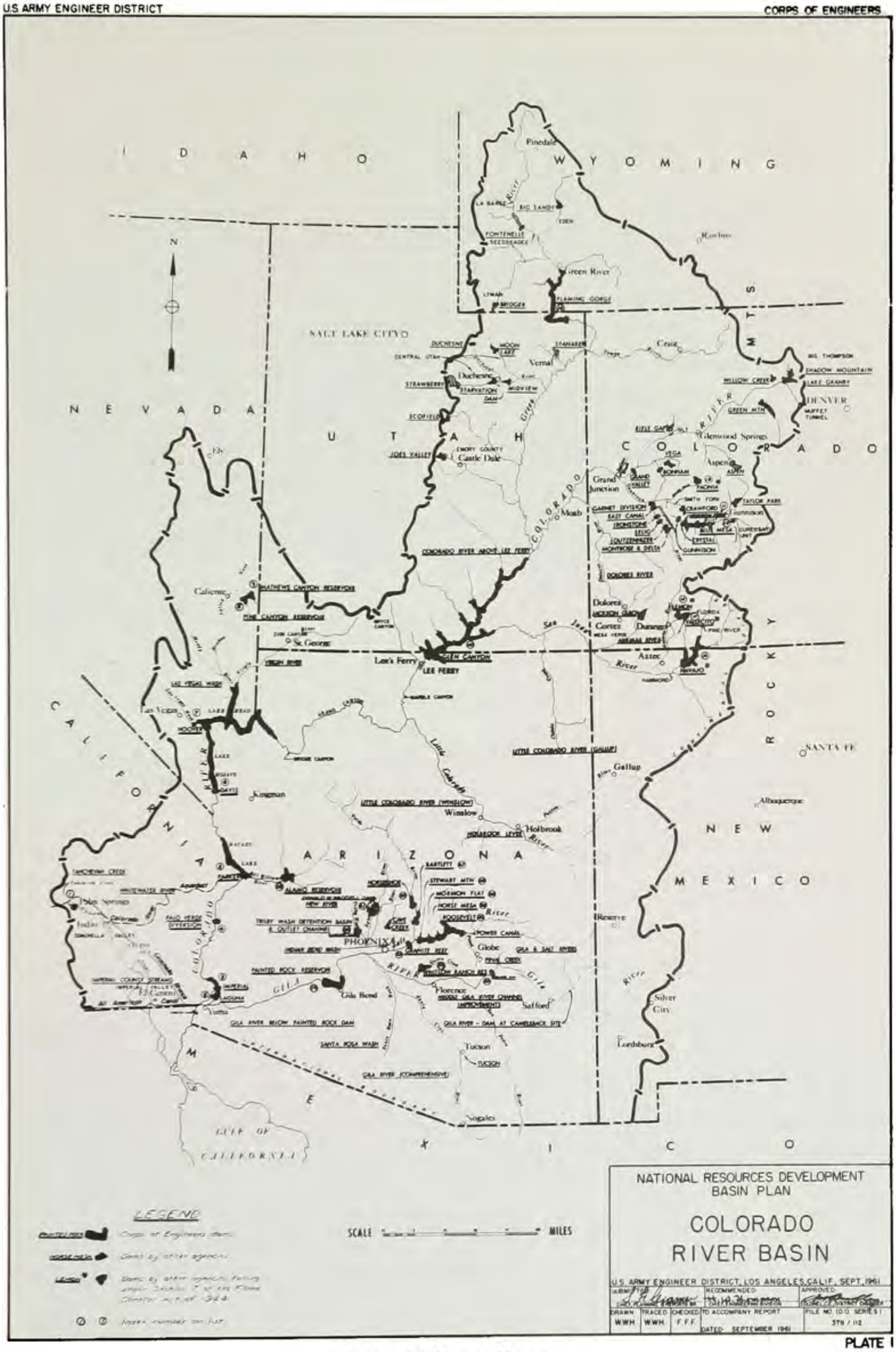
In addition to, and even more important than, the significant role the Corps has in flood control is the goal of preserving the Number One Natural Resource of the country, "Water." The Corps recognized the importance of water to the development of the nation as a result of its many years of experience in civil works. Upon proper authorization from Congress this experience of the Corps is made available to local, State, and other Federal agencies for the resolution of water problems.

The arid nature of the area within the environs of the Los Angeles District and the need to meet the water and recreational demands of the most rapidly expanding population in the United States required careful and imaginative planning by local, State, and Federal agencies. Fortunately, men of vision, both within and outside the government circles have met the challenge.

By 1965 long-range, comprehensive regional planning was underway to resolve the problem of proper utilization of water resources to meet the growing water demands of the Pacific Southwest, as the water service area of the Lower Colorado River Basin, including southern California, is defined in the *Report, Pacific Southwest Water Plan, January 1964,* United States Department of Interior.

The Los Angeles District cooperated, and continues to cooperate, under Congressional authorizations, with all levels of government in the development of a sound water resources program, which encompasses all principal watersheds, many of the smaller streams, and the harbors and coastline beaches of southern California within District boundaries.

Implementation of the above was apparent in 1940, when Lieutenant Colonel Edwin C. Kelton reported that in accordance with regulations established by Congress consideration of any flood control project also embodied a study of related problems, including navigation, water power, and water conservation. Accordingly, all flood control projects investigated or executed by LAD were planned with careful consideration for all uses of water in order to provide maximum public benefit. Where warranted, multipurpose projects could be authorized. Certain factors mitigated against the extensive development of multipurpose projects within the District. In 1940 LAD concluded that the development of electrical power from water supplies in southern California was not feasible and the type of flood control improvements



Colorado River Basin.

People by the thousands enjoy the beautiful facilities of famous Mission Bay. Army Engineers built entrance facilities and main access channel including two side boat basins.

Recreational boating under observation of onlookers at Mission Bay.

adaptable to the area offered no possibilities for direct coordination with navigation interests except in connection with the Alamitos Bay.

An outstanding exception to the conclusion in 1940 by LAD with regard to the coordination of flood control with navigation improvements occurred in 1946 when Congress authorized a dual-purpose project for flood control on the San Diego River and navigation of light-draft vessels in Mission Bay. Completion in 1953 of a leveed flood control channel conducted flows in the San Diego River directly to the ocean. The navigation features of the project which were functionally complete in 1959 included entrance jetties which served to stabilize both the navigation entrance channel and the mouth of the San Diego River floodway. A common feature of both flood control and navigation improvements was the middle jetty which separates the floodway from the navigation channel. The net results include not only flood protection but also Mission Bay Harbor, one of the most scenic water-oriented recreational areas in the world which provides enjoyment to tens of thousands vacationing tourists as well as San Diegans. These recreation enthusiasts eventually will have at their command a beautiful scenic Mission Bay Harbor area of about 2,000 acres of navigable water and an equal area of land, both used entirely for recreational and sport-fishing purposes. Berthing about 2,000 small boats in 1965, the harbor eventually will berth about 3,000 small craft.

In addition to present facilities, ultimate public recreational development of the project calls for a magnificent aquatic park at an estimated cost of about $106,000,000 of which private interests will spend about $50,000,000 for marinas, motels, boatels, vacation complexes, a marine park, and other accommodations – an outstanding dual-purpose creation of the Los Angeles District with excellent cooperation from public officials and private interests of metropolitan San Diego.

With the lack of reservoir sites of sufficient capacity for continuous water power operation, with the rapid runoff after each flood-producing storm, and with a long dry season as well as dry cycles lasting for a number of years not uncommon, there were only a few water power plants within southern California operating from local water supplies. Moreover, the supply of electricity from municipal, Federal (Boulder Dam), and private plants appeared adequate to supply the needs until 1970.

With respect to water conservation, river basin planning, and recreation, LAD has had more success than in water power development discussed above. In his excellent study (1959) on the flood control problem of the extensive Los Angeles Metropolis, Harold E. Hedger,

retired Chief Engineer of the Los Angeles County Flood Control District (LACFCD), corroborated the findings of the officials of LAD, which they made in the late 1930's and early 1940's, with regard to the Los Angeles County Drainage Area Project. Their examination of topographic and climatic conditions in southern California revealed the close relationship which existed between the functions of flood control and water conservation and the vital necessity for each. The scarcity of water in southern California indicated the necessity to assign a high priority to the conservation of water from every available source. In recognition of this, the Enabling Act by the California State Legislature in 1915 which created the Los Angeles County Flood Control District assigned to that district not only flood control responsibilities but also the conservation of "such waters for beneficial and useful purposes by spreading, storing, retaining or causing to percolate into the soil within said District." Moreover, this act created the major local agency which worked with LAD and also concentrated on the solutions of flood control problems which lay outside Federal jurisdiction.

LAD assists LACFCD in carrying out its functions. While under the provisions of the Federal Flood Control Act of 1936 LAD facilities are directed primarily at the control of floodwaters, they also, by reduction of flood peaks through temporary storage, have a beneficial and positive conservational result. Hedger noted that the "release of controlled flows, relatively free from debris," made "it feasible to divert a portion of those flows from stream channels to spreading grounds and basins as a replenishment measure." He concluded that, "as a long time annual average, about 20,000 acre-feet of floodwaters which otherwise might be lost to the ocean will be conserved each year in the stream channels and spreading grounds which have been developed in the central basin. This would constitute a normal supply for approximately 100,000 people in this area alone."

Even after completion of a single-purpose flood control project, Congress may authorize modifications, including water conservation. Originally the Whittier Narrows Reservoir was constructed as a single-purpose flood control project, but LAD at the request of local authorities obtained Congressional authorization to modify the project so that now LAD operates a 1,000 acre-foot pool in the reservoir to supply releases for the downstream spreading operations of the Los Angeles County Flood Control District. The same principle of water conservation was applied over and over again. Thus modifications of the Prado Dam, which provides protection primarily for Orange County, California, produced an average long-term annual increase in percolation within the Santa Ana River basin. The increase occurred when LAD obtained permission, in October 1946, for the Orange County Water District to close the west ungated bypass. Efforts to further increase

Prado Dam and Reservoir. Combining water conservation with flood control.

water conservation in the basin by closing another ungated outlet at Prado Dam were unsuccessful in 1965, because of the need to iron out complicated water rights and have a local agency assume responsibility to adjust all claims for damages which might result from the change in operation of the dam. However, by this time many changes in the project, the drainage area, and in planning concepts for civil works led to authorization by Congress for LAD to review previous reports to determine the advisability of providing additional flood control, water conservation, recreation, and related improvements, including environmental and esthetic considerations with a report scheduled for completion by 1970. Thus, changing requirements for water usage made it desirable to review reservoir storage allocations to insure satisfaction of changing needs. In addition to the above projects, LAD gave high priority to water conservation at other flood control facilities in southern California, Arizona, Utah and Nevada.

To cope with the considerable amount of work involved, LAD expanded its work force many times. In 1936 LAD started with a force of three engineers on flood control work, but, as Colonel Kelton reported in 1942, it was necessary to increase the staff to a total of 60,

not including engineers who did special work on the survey reports in connection with hydraulics, hydrology, and structural design. By 1965 more than 70 members of the District, including the specialists, were directly involved in the preparation of flood control reports, a clear indication of the continuing importance of multipurpose water projects for the District and the people within the bounds of the District.

As Colonel Earl G. Peacock, District Engineer, related in 1964, new techniques were being developed and new disciplines were being employed in the design of water-resource systems. In order to justify proposed projects, the old conventional economic approach underwent modification to include new socio-economic aspects and to make economic studies not only for the project area but also for the regions encompassing that area. Computer programs were developed to optimize resource utilization and to allocate water to the several purposes of multipurpose projects. More significant was Colonel Peacock's conclusion that to attain the full and efficient development, utilization, and conservation of all natural resources for the purpose of advancing the national economy and promoting the public welfare, comprehensive framework studies of river basins were required. Under this concept each river basin would be developed under a single comprehensive plan, multiple-purpose in scope and consolidating all developmental activities into a coordinated whole.

Interestingly, Seldon F. Cramer, former Chief, Project Planning Branch, LAD, noted in 1965 that "in 1908 the Inland Waterways Commission identified all, or almost all, the strands of conservation thought and action that crowded the intervening years and today supply a still persistent agenda of unfinished business."

Among those strands was the concept of river basin planning, but the implementation of that concept materialized slowly with the first step taken in 1928 when Congress authorized the Corps of Engineers to study the feasibility of developing the rivers of the United States for navigation, irrigation, flood control and power in general. These studies became famous as the "308 reports," which suggested general plans for possible development of numerous river basins. However, no "308 reports" were ever authorized for river basins within the Los Angeles District. Since the Federal Government had not yet accepted general responsibility for flood control or power development, the plans were not actualized. After 1936, when the Federal Government established a definite flood control policy, Congress periodically passed legislation that broadened Federal responsibilities in the development of water resources. For example, the Flood Control Act of 1944 authorized the Corps to include in its flood control investigations consideration of the optimum use of water originating in river basins. The Water Supply Act

of 1958 made it feasible to include the storage of water in any reservoir project for existing or anticipated domestic, municipal, or industrial needs. Also given full consideration are water quality and pollution control under the 1956 Water Pollution Control Act and other acts, including the Water Quality Act of 1965 and the Clean Water Restoration Act of 1966. To coordinate natural-resources planning, Congress passed the Water Resources Planning Act of 1965 which also established a water-resources council and permitted the formation of river-basin commissions.

With these far-sighted concepts, LAD was authorized to participate in comprehensive framework studies of water and land resources for the State of California and the Lower Colorado River Basin. These studies require coordinated efforts between the States and various Federal agencies engaged in water resources development, including agencies within the Departments of Defense, Interior, Agriculture, and Health, Education and Welfare.

The inevitable question arises of how this conglomerate of governmental agencies could achieve the stated objectives. Contrary to the opinions of critics, officials of LAD reported that there had been far greater cooperation than rivalry between these agencies. As far back as 1938 Major Theodore Wyman, Jr., District Engineer, attempted to dispel any thoughts that there was duplication of efforts by the several departments of the Federal Government then involved in the water resources area, including the Department of Agriculture, the Bureau of Reclamation, the Weather Bureau, the Coast and Geodetic Survey, the Geological Survey, and the Corps of Engineers. He indicated that each of these branches of the government "is highly specialized in its particular field, but none is overlapping in its particular field." The data collected by one department is available to all other departments, and when called for there was a willing exchange of information. Moreover, for years, he reiterated, "the Corps in carrying out investigations of navigation and flood control projects called for by Congress, had made use of facilities of a number of other Federal departments and bureaus, and has assured itself that its work was coordinated with the activities of the other branches of the Federal Government and with the agencies of State and local governments." He concluded: "The cordial character of the cooperation between the various separate agencies of the Government is most gratifying and impressive."

In 1960 Lieutenant General E. C. Itschner, Chief of Engineers, declared that proper delineation of responsibilities between agencies like the Corps of Engineers and the Bureau of Reclamation was easily accomplished and "that it is far less important who does the work than that the construction be accomplished if there is a need for it."

Since its inception, LAD has cooperated in the improvement of procedures for coordination of all activities, Federal, State, and local, public and private, affecting water resources. An excellent example is an investigation, scheduled for completion in July 1971, to formulate a framework plan for comprehensive development of the water and related land resources of the State of California. Among personnel of the District involved in this framework study were Charles H. Fisher, Marjorie Cushman, Clarence J. Bergschneider, John W. W. Bogue, and Haden H. Helm. This group and other personnel of LAD also contributed to other framework studies, particularly to the Lower Colorado Region Comprehensive Framework Study.

The public demand for recreation facilities alerted the government to recreation opportunities as a byproduct of many government projects. Ever since the enactment of the Flood Control Act of 1944, the Corps has provided recreation in its projects. In 1965 Colonel John A. B. Dillard, District Engineer, related that the magnitude of the recreation potential was hardly anticipated in the 1930's when Congress authorized the work that brought into existence many great water resources projects. Some of these reservoirs like the Hoover Dam demonstrated their attraction to recreationists. Not until the Corps accumulated sufficient data to illuminate the problem did Congress grant the Corps considerable latitude for planning and development of recreation. In spite of this charge, the responsibilities of developing recreation potentials at reservoirs were held to a minimum by the Bureau of the Budget and Appropriation Committees in Congress, who thought that other demands had higher priorities than recreation. Congress did permit the Corps to lease Federally owned land within flood control facilities to local interests to develop recreational facilities and to bear developmental costs.

The American economy afforded people more and more leisure hours to spend in relaxation and refreshing outdoor activities to relieve tense urban living and provided them with adequate personal incomes allowing vacation travel, plus increasing ease of travel by all modes. These facts made it evident that the capacity of facilities at too many projects was not adequate to meet the insatiable demand. The changes in policies necessary and desirable to develop the full potential for recreation at most projects became a reality with the passage of the Federal Water Project Recreation Act of 1965. Haden H. Helm, LAD, concluded "that recreation has been elevated from a secondary to a primary project purpose in virtually all multipurpose Federal projects."

LAD assisted local and State authorities in their efforts to meet this demand by the public for water-related outdoor recreation. Prior to 1965, LAD leased land to local and State governmental agencies for

Whittier Narrows Dam and Reservoir on the Rio Hondo and the San Gabriel River in Metropolitan Los Angeles, showing recreational facilities already completed or under construction by the County of Los Angeles Department of Parks and Recreation and local citizens' organizations. Similar developments were underway at the Santa Fe Dam and Reservoir, which is at the top center of the picture, and other flood control projects.

development of the recreational potentials at its reservoirs. In 1965 Colonel Dillard reported that of the 12 existing reservoir flood control projects in nine southern California counties recreational development by local agencies was under way at six, and either under consideration or in various stages of planning at the other six. These reservoirs were at Brea, Carbon Canyon, Fullerton, Hansen, Lopez, Mojave River, Prado, Salinas, San Antonio, Santa Fe, Sepulveda, and Whittier Narrows. Recreational development also was under way at the Isabella and Poso Creek Reservoirs in Kern County.

At the reservoirs local agencies provide myriad activities, such as picnicking, fishing, hiking, horseback riding, archery, golfing, swimming, pistol and trap shooting, field sports, and model airplane flying. In addition, wildlife preserves are maintained at some of these reservoirs.

Water Recreation at Whittier Narrows Dam and Reservoir.

Following the equestrian trail at Hansen Dam and Reservoir.

Picnicking at Whittier Narrows.

Golfing is a popular sport at flood control reservoirs, as shown by the golfers on the links at Whittier Narrows.

Little League baseball team in action in the Sepulveda Flood Control Basin. Land available to the City of Los Angeles recreational development totals more than 1,600 acres.

Using the skeet shooting facilities at Whittier Narrows provided by the Los Angeles County Department of Parks and Recreation.

Probably the recreational pride of the Los Angeles District is the Whittier Narrows Dam Recreational Area, the site of the annual District picnic. In July 1957 the Corps of Engineers granted a 50-year license to the County of Los Angeles for use of 1,161 acres of the flood control reservoir as a regional park. Completed or planned by officials of Los Angeles County by 1965 were the following facilities: an 85-acre fishing lake, picnic areas, an equestrian center, an 18- and a 9-hole golf course, a trap and skeet shooting area, a children's amusement center, a field archery range, a model race car area, a rifle and pistol range, a swim park, baseball and softball diamonds, and other athletic facilities. Thousands of families enjoy the use of these facilities at little or no cost. The Pomona Freeway provides easy access to the various facilities. None of these activities interferes with the prime function of the dam to control floods. Thus the ever-increasing population of southern California has a magnificent recreational facility to enjoy.

To 1965, local interests had spent about $9,000,000 on recreational development in southern California, but more than 60 million additional dollars will be required to complete the envisaged development at LAD reservoirs. Unfortunately, the total acreage at these 14 reservoirs satisfies only about 1 percent of the demand for outdoor recreation. Nevertheless, the facilities are visited annually by about 7,000,000 people, with a prediction of 30,000,000 annual visits when ultimate development at all 14 reservoirs is complete. Year after year the recreational areas in the civil works projects constructed by LAD have been and are among the most popular in the country. For example, for the calendar year 1953 Hansen Dam was one of the 10 most popular recreational areas in the country with over 1-1/2 million visitors and in 1965 its popularity continued. Since these facilities are subject to damage when floods occur, they are not always available to the public.

Lack of funds on the part of local agencies hampers the development and operation of urgently needed public recreation facilities. Cognizant of this problem Congress has expanded the authority of the Corps to assist in the resolution of this problem by including recreational facilities in water projects. Brigadier General William M. Glasgow, Jr., South Pacific Division Engineer, showed how quickly the Corps implemented this authority. In his remarks at the dedication ceremonies at Alamo Dam, originally authorized by the 1944 Flood Control Act, in 1969 he noted: "Alamo Dam – and the lake and park associated with it – are a kind of landmark for the Corps. This is the first project we have ever built in Arizona which includes major recreational areas. It is the first time we have entered into agreement with the State of Arizona to operate Corps-built recreational facilities." The State of Arizona will have the responsibility to operate the entire 22,000 acres as a public recreation site and a wildlife conservation area.

Planned facilities for Alamo Dam and Reservoir, an example of a multipurpose project, providing flood control, water conservation and a permanent pool for recreation, fish and wildlife developments.

Unfortunately, with land at a premium the temptation to utilize the attractive open space around flood control projects in urban areas for other than recreation is difficult to resist. Upon the Corps is placed the unpopular task of preserving and protecting this prime recreational space from the requests by local entities to use the land for other purposes. Thus, LAD has to be a watchdog. The staff of the District is constantly alert to prevent unreasonable encroachment on the land set aside for recreational development. This vigilance, reinforced by support from officials concerned with parks and recreation, has thwarted the varied request of private and public interest groups to utilize undeveloped recreation land for purposes other than the intention of Congress.

Congress did authorize the granting of easements for the placement of natural gas, electric power, and sewerlines if they did not interfere with

the flood control purpose of the projects. In one instance LAD granted a 50-year easement at no cost to the City of Chino for the construction of a sewage treatment plant within the northwest corner of the Prado Flood Control Basin. This exception was based on the importance to this basin of the effluent for irrigation purposes.

The Fire Department of the City of Los Angeles has requested the use of 10 acres in the Sepulveda Dam area for a fire station, and the Highway Patrol of the State of California has asked for 1-1/2 acres of basin land for a station. LAD thinks these demands shortsighted, since the San Fernando Valley has the fewest recreational facilities per capita of any part of the City of Los Angeles, but pressure is being exerted to change the conditions of the original lease agreement which forbid the use of reservoir land for such purposes. Hopefully, these open spaces in the District will be developed to increase recreational opportunities.

In his analysis of three categories of recreational areas – flood control, navigation, and beach erosion projects – Colonel Dillard concluded "that the Los Angeles District has marched farther down the road toward meeting recreational demands than might be generally realized." Clearly LAD closely followed the basic philosophy of the Corps of Engineers, as expressed by Brigadier General Glasgow and other personnel of the Corps, to develop "water resources projects with the long view that they will serve as many citizens as possible in as many ways as we can devise."

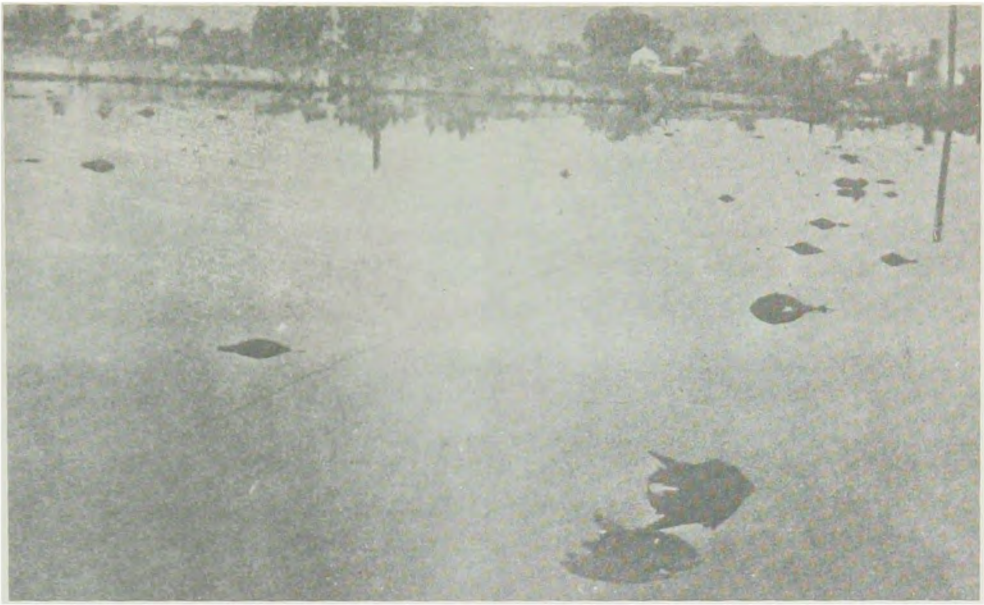
Closely related to water resources development is the problem of water pollution. Contrary to the lamentations of the ecologists and environmentalists, water pollution has long been recognized by the Federal Government as a problem affecting the general public welfare. It is generally forgotten that the Corps of Engineers only reflects the thinking of the general public through its particular agent, Congress. Whenever a matter of pollution was brought to the attention of Congress, Congress usually dealt with the matter.

Colonel Carroll T. Newton, in his testimony at the California State Assembly Interim Committee Hearing on Bay and Water Pollution, held on July 2, 1958 at the City Hall, Newport Beach, ably summarized the work of Congress and the District to that date as follows:

Congress enacted many laws for pollution control or abatement whenever the particular problem was considered beyond the capabilities or authorities of State or local governments. Congress made the administration of Federal legislation pertaining to the pollution of navigable waters the responsibility of the Secretary of the Army, acting through the Corps of Engineers. The first important provision appeared

Pollution in the 1930's. (Photographs from LAD, *Oil and Refuse Pollution,* 1939.) Trash and oil on harbor waters constituted a serious fire hazard, as well as creating unsightly and unsanitary conditions in slips, around floats and under piers.

Above shows a beach temporarily ruined for recreational use by oil discharged in violation of Federal and State laws.



Wild fowl killed by floating oil.

Fish as well as birds are killed by polluted waters.

Boom for surrounding oil spills located on Standard Oil Co. dock.

Garbage and refuse illegally thrown overboard from offshore ships washes onto the beaches, spoiling them for recreational use until they are cleaned (June 1938).

in the River and Harbor Act, March 3, 1899. Section 13 of that law makes it unlawful to throw, discharge, or deposit any refuse material of any kind either into navigable waters, or on the banks where it could be washed into navigable waters, or their tributaries which would impede, or obstruct navigation. Exceptions are made for drainage from streets, liquid flow from sewers, operations in connection with the construction of public works, or improvement of navigable waters. In addition, under specific conditions, the Secretary of the Army could permit material to be deposited in navigable waters, but only in definite areas where there could be no injurious effect upon anchorage or navigation.

In 1924 in recognition of the dangers to harbor waters of oil pollution, Congress placed under the Corps the administration of the Oil Pollution Act. This Act made it illegal to discharge or permit the discharge of any kind of oil into the coastal navigable waters of the United States, except in the case of emergency, the protection of life or property, or unavoidable accident, collision, or stranding.

The prevention of pollution also influenced the activities of the Corps of Engineers in other fields. For example, no construction or remedial beach erosion facilities were permitted to protect polluted beaches. Local communities were responsible for controlling the pollution of beaches. In the enforcement of anti-pollution laws, LAD cooperated to the fullest extent with State and local agencies. This cooperation permitted LAD to instruct these agencies in their responsibilities for the control of pollution.

In southern California, oil created the major pollution problems. In 1958 LAD officials considered the problem controllable because of the continuous educational campaign by both Federal and local agencies on the seriousness of the oil pollution problem. Almost all of the reports of pollution incidents, referred to the District before 1958, involved accidental oil spills into navigable waters while transferring oil between ships and between ship and shore installations. Only a few pollution incidents required prosecution by local, State, or Federal authorities. The general policy of LAD was to cooperate with local and State agencies in the enforcement of anti-pollution laws and to recommend Federal prosecution only in unusual circumstances. Since under local or State prosecution punishment quickly followed an offense, LAD preferred their action to Federal action, but the threat of Federal prosecution was ever present. While fines were nominal, legal expenses for defending a case in Federal court were frightening. By these actions LAD often turned oil spills into self-policing operations, for failure to clean up a spill resulted in local or Federal prosecution, or both. Faced with that prospect the violator preferred to employ professionals to clean up an oil spill immediately, even though the costs probably

exceeded any fine that might be levied. Officials of LAD estimated that cleanup costs in the Los Angeles-Long Beach Harbors had run as high as $30,000 for a single oil spill. Some evidence of success was apparent. Although the number of incidents reported each year remained about the same, about 30, those involving large quantities of oil or incidents demonstrating gross negligence diminished.

Within the tidelands of California lie valuable deposits of oil which are owned by the Federal and State governments. Through leases obtained by competitive bidding, private oil companies control offshore oil development. Leases within Federal tidelands are issued by the Department of Interior. In order to drill oil wells, the companies built artificial islands upon which oil drilling rigs were placed. Permits for the placement of these structures come under the jurisdiction of the Secretary of the Army. Until 1965 no incidents involving offshore oil drilling occurred.

Through its civil works the Los Angeles District clearly performs a constructive role in planning the development of water resources, in furthering recreational development, and in controlling pollution of waters.

In cooperation with local, State, and other Federal agencies, the Corps of Engineers strove in 1965 to develop a program in water resources which would satisfy the demands of the American people.

CHAPTER VII

THE LOS ANGELES DISTRICT IN ITS MILITARY ROLE

Over and over again the wisdom and foresight of the Founding Fathers has been demonstrated. A prime example was the creation by Congress of a dual civil-military organization, the Corps of Engineers. By virtue of civil works' functions of the Corps the American nation maintained in existence an engineering and construction agency around which technical resources were mobilized in times of national emergency. As an important component of the Corps of Engineers, the Los Angeles District took justifiable pride in its record of discharging military construction responsibilities as well as resolving many complex and unusual engineering problems in civil works. LAD simply carries on in the long and worthy tradition of the Corps of Engineers.

In the first decades of its existence the weak and beleaguered American government, confronted with a precarious international situation, assigned the responsibility for coastal defenses to the newly created Corps of Engineers. Following the debacle of the War of 1812, Congress established the Board of Engineers for Fortifications on November 16, 1816 with the mission of providing the country with proper fortifications. Initially, its work was concentrated along the Atlantic coast, but with expansion westward of the country Congress authorized the Board to extend its program to the Great Lakes, the Ohio and Mississippi-Missouri basins, the Gulf of Mexico, and the Pacific coast. This Board planned a comprehensive program of national defense which united military defense, commerce, and internal transportation. The validity of this principle that communications were an integral part of national defense has been best illustrated in the 20th century. In 1953 Lieutenant General Lewis A. Pick, Chief of Engineers, pointed out that the system of harbors – 286 of them – developed by the Corps, not one of which in its natural state could handle modern deep-draft vessels, became the springboards to launch men and materials with which victories were forged in two crucial world wars.

Corps-improved inland waterways, which carried millions of tons of commerce in peacetime, during wars moved vast amounts of bulk freight which lessened the strain on other overburdened systems of transportation. Investments in water resources resulted in built-in convertible features of national progress and national defense.

The relentless westward movement and the California gold rush produced Congressional appropriations for geographical and military surveys west of the Mississippi. Topographical engineers explored the West and located and built wagon roads and military posts. Both the Corps of Topographical Engineers and the Corps of Engineers concluded that the best transportation method to the Pacific was a transcontinental railroad. In the 1850's, Congress authorized the Army Engineers to survey routes for a Pacific railroad and to take into consideration their military aspects. Many Army engineers and other officers who participated in these surveys applied their experiences successfully during the Civil War. Moreover, railroads, constructed prior to the war with the assistance of Army Engineers, also contributed to the military success of the North.

On the Pacific coast, although the major emphasis was on the defense of the harbor at San Francisco, fortifications also were provided for the harbor at San Diego. In 1872 plans were made for the construction of earthen seacoast batteries with guns of the largest caliber to protect this important harbor in southern California. In that same year the Board of Engineers for the Pacific Coast, consisting of Lieutenant Colonel B. S. Alexander, Lieutenant Colonel C. S. Stewart, and Major George H. Mendell, with Captain Thomas H. Handbury as recorder, every one of them important to the development of southern California, perfected details of fortifications under construction, prepared projects for future fortifications and resurveyed the San Diego Harbor to determine whether any changes of a detrimental nature had taken place in the channel since 1856. On the latter the Board concluded that the existing channel was satisfactory for shipping.

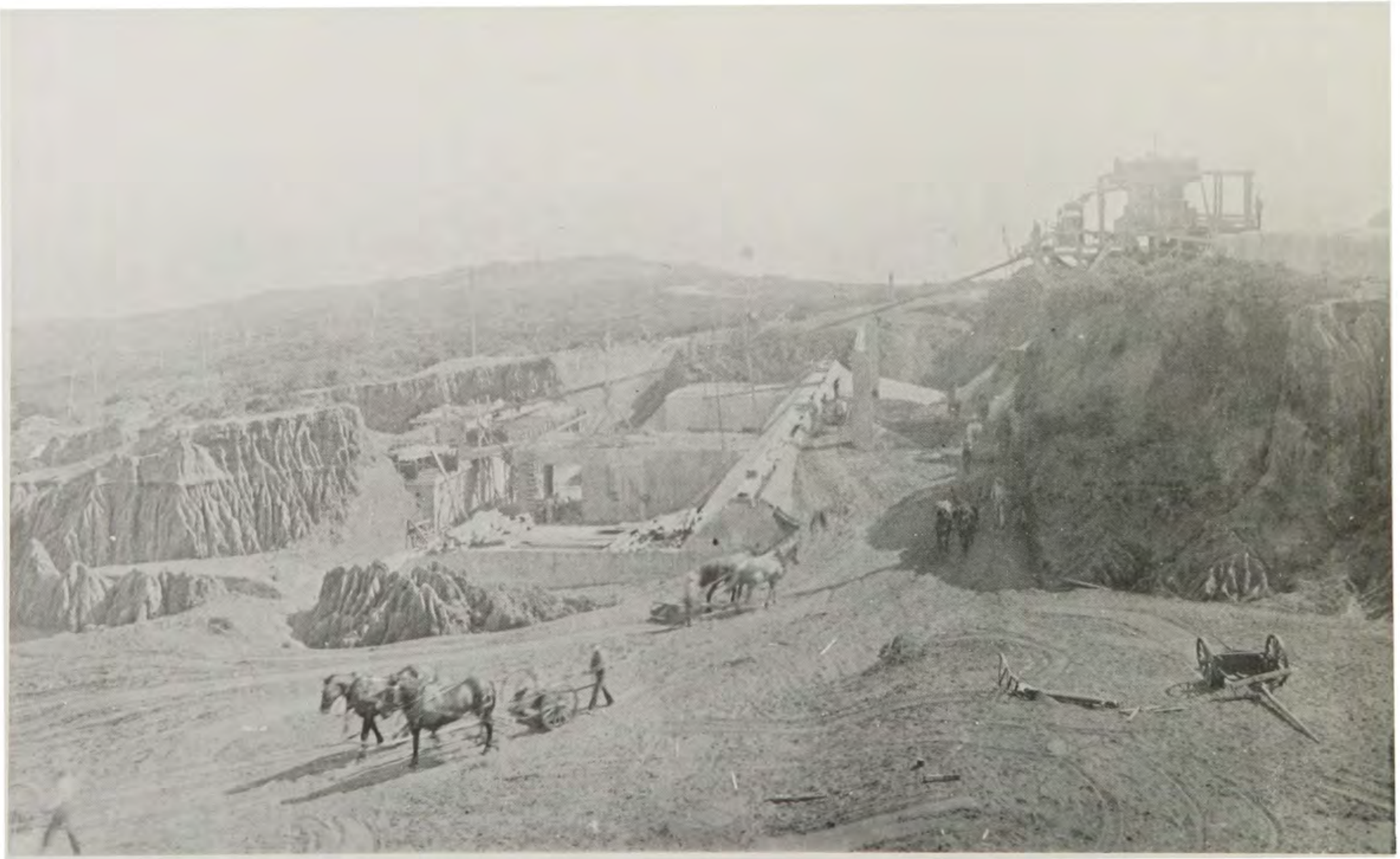
Ultimately, the defense requirements of San Diego Harbor became the economic salvation of San Diego after the failure of the town to become a transcontinental railroad terminus, for topographical surveys found no feasible railroad route between the Gila River and San Diego. LAD made valuable contributions to the economic development of San Diego in constructing military installations and improving the harbor when authorized. Prior to the Spanish-American War some fortifications to protect the harbor were built. Military defenses in the Pacific languished in spite of the obligations of the country, incurred as a result of that war. LAD did begin a dredging project to eliminate shoaling and began to construct jetties at the entrance to the bay. The quick victory of the United States halted work on the construction of a new fort on Point Loma. During the war Captain J. J. Meyler not only directed the construction of fortifications for San Diego Harbor, but also supervised submarine mine operations, which at that time were the responsibility of the Army Corps of Engineers. To carry out this unusual assignment,

Captain Meyler recruited a volunteer company of citizens, consisting of approximately 80 men, including civil engineers, surveyors, carpenters, electricians, mechanics, boatmen, boiler-makers, steam engineers as well as a handful of engineer soldiers. This group placed 15 electrically controlled mines in the main channel on May 23 and 24, 1898 and removed them in September of that year when the probable danger from the Spanish fleet evaporated with its defeat, in Manila Bay, by Admiral George Dewey.

In 1899, reservation land, set aside for military purposes in 1852, was converted into an encampment and named Fort Rosecrans in honor of Major General William S. Rosecrans. After the turn of the century, gun batteries were placed on Ballast Point on the east side of Point Loma. In 1905 another Army fort was built on North Island within San Diego Bay and named Fort Pico to honor the last Mexican governor of California. The Zuniga jetty protecting the San Diego harbor entrance and dredging the channel to a width of 500 feet and a depth of 24 feet at mean low tide were completed. Congressman William Kettner won a hero's welcome in San Diego for his success in obtaining appropriations for the naval coaling station on Point Loma, for a new naval radio station to improve the defensive capabilities of Fort Rosecrans, and for mapping the kelp beds.

Because of its favorable climate, San Diego became a center of aviation as the airplane proved its value as a new instrument of military technology. In 1912 on North Island, a base for naval aviation and an aviation school for the Army Signal Corps, with the latter located on a base named Rockwell Field, were established. During World War I the Army purchased all of North Island and founded a training camp, named in honor of General Stephen Watts Kearney, a hero of the Mexican War. The Navy also expanded its installations. As a result San Diego became a major center for naval operations and aviation, both Army and Navy. LAD also had the mission to convert San Diego Bay into one of the great harbors of the world. During this period LAD also improved installations at Fort MacArthur, the major unit for the defense of the Los Angeles Harbor.

Officers and civilians used the experience, knowledge, and skills acquired during their peacetime service with LAD to perform exemplarily in France during World War I. For example, Brigadier General Amos A. Fries, the commander and organizer of the "Gas Service" which later became the Chemical Warfare Service of the American Expeditionary Force, served as District Engineer (1906-1909) and played a significant role in the development of Los Angeles Harbor. Another former District Engineer (1902-1903), Major General Edgar Jadwin, earned the Distinguished Service Medal for his work with



Constructing a battery at Ft. Rosecrans, April 17, 1916.

Hauling a base ring for 12-inch mortar with teams of horses by Pioneer Truck Company, Ft. MacArthur, California, September 23, 1916.

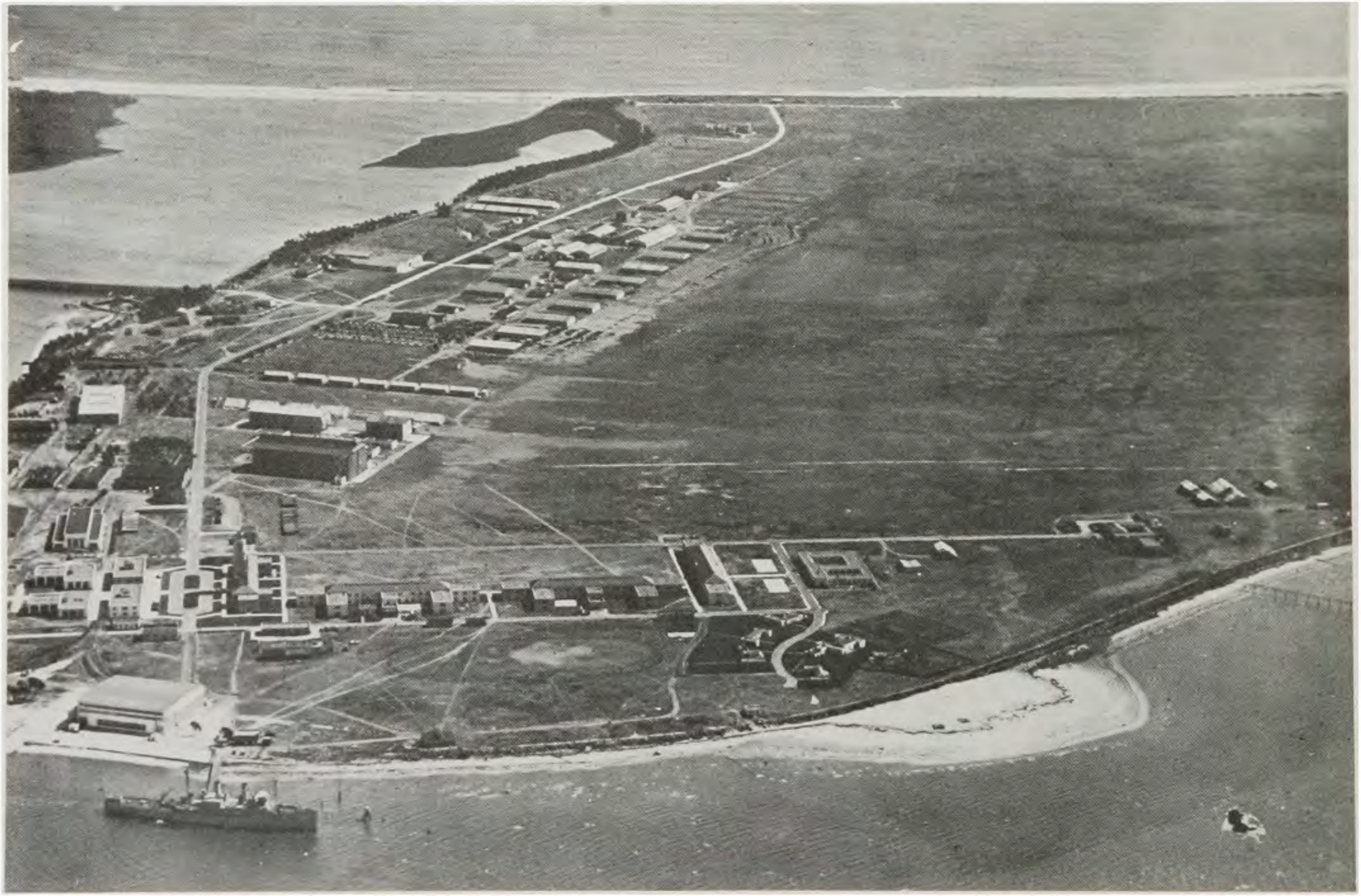
Trucks used by Los Angeles District to supplement horsedrawn equipment, Ft. MacArthur, California, 1916.

Pouring concrete, mixer and 6-ton Locomobile truck in use, Ft. MacArthur, California, October 28, 1916.

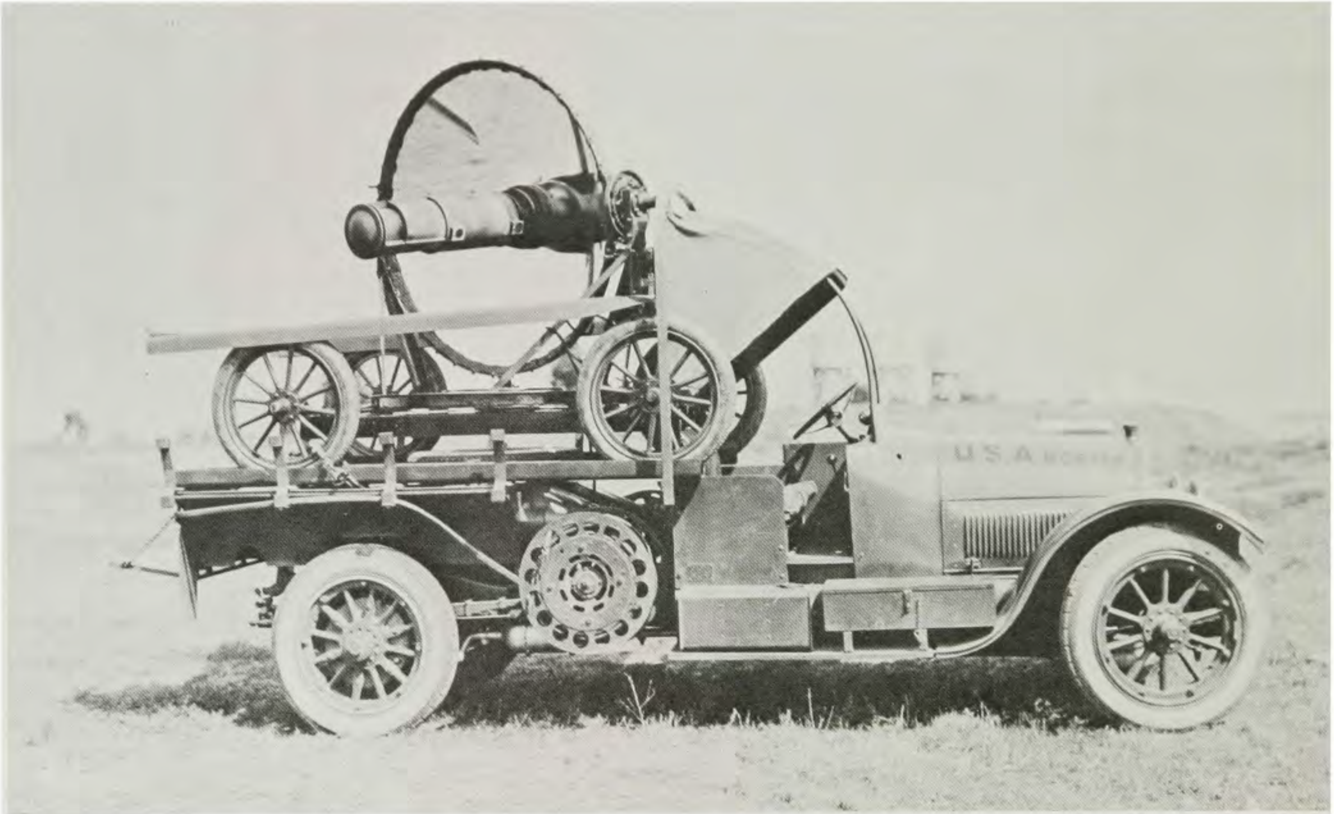
Construction in progress for mortar battery, Ft. MacArthur, California, December 16, 1916.

Capt. A. H. Acher, project officer, with one of the early automobiles used by Los Angeles District, Ft. MacArthur, California project, June 9, 1917.

Hudson Limousine, licensed U.S. 1815, for use by District Engineer, LAD, received April 28, 1919.



Fill on North Island, San Diego Bay, by Navy Department with authorization by permit from LAD, August 29, 1921.



Searchlight mounted on Cadillac chassis, mobile searchlights, Numbers 1 to 6, Ft. MacArthur, California, September 15, 1921. Recognition of need for defense against air power, the new dimension to war.

construction projects (AEF). He also helped build the Panama Canal, served as Chief of Engineers, and formulated the Jadwin Plan to tame the Mississippi River before retiring as Lieutenant General. The Corps of Engineers, drawing together nine railway engineer regiments, created the Transportation Corps. In 1918 the Corps was called upon to organize a Tank Service which became the nucleus of the armored might of World War II.

After World War I and up to 1933 the Corps of Engineers decreased drastically in size as the Federal government went on an economy drive. To combat the economic crisis of the 1930's, the New Deal embarked on a public works program which immediately expanded numerically and functionally the Corps of Engineers. Like the other districts, LAD increased its work forces, which on the 30th of July 1938 consisted of over 18,000 employees, including WPA employees. With discontinuance of the latter group, the number of employees decreased until fewer than 700 employees were in the District in February 1939. The permanent staff had acquired experience in large scale construction work and the necessary knowledge of how to contract and with whom to contract, as was true of the rest of the nationwide network of divisions and districts of the Corps of Engineers.

This state of affairs within the Corps of Engineers was fortunate, for the country now began to recognize, albeit reluctantly, the dangerous international situation created by the aggressor nations of the 1930's. As crisis after crisis arose in Europe and Asia, the Roosevelt Administration turned to a preparedness program for national defense. In April 1939 Congress responded with large sums for Navy and Army airbases and other military works; this was known as the Initial Defense Appropriation Act. Not until the collapse of France in May 1940 was there appreciable defense activity, except for the Navy's rush work in the Pacific. Then apathy and complacency with the status quo evaporated. With speed reminiscent of the First Hundred Days of the New Deal, Congress passed legislation in June, July, August, and September 1940 and in March and April 1941 appropriating or authorizing billions for defense. Never before had the Army and Navy been confronted with such a challenge by Congress. The Armed Forces met that challenge.

Activity within the Los Angeles District reacted to this pattern. Under the leadership of Lieutenant Colonel Edwin C. Kelton, District Engineer, LAD adapted to the difficulties of the changing requirements of the defense program and the multiplicity of the types of emergency construction involved in the preparedness program for national defense. In February 1939 work to strengthen harbor defenses commenced with authorization for the design and construction of gun emplacements at

Forts MacArthur and Rosecrans. After the transfer of all Air Corps construction to the Corps of Engineers in November 1940, LAD assumed responsibility for the design and construction of all Air Corps projects in the District on December 15, 1940. At the time of the takeover, projects under the direction of the Constructing Quartermaster were underway in the District at March Field, Hill Field, Muroc Banking Range, Mines Field (Los Angeles International Airport today), and Wendover Bombing Range. In addition, during the fiscal year 1941 LAD began work on 12 landing areas for the air patrols of the Civil Aeronautics Administration. These patrols performed air surveillance, a valuable function for national defense. To accomplish all these tasks, the District increased its manpower, so that on December 7, 1941 there were over 2,100 employees. The transfer of activities from the Quartermaster General to the Engineer Department brought about a shift of the bulk of the employees from the Office of the Constructing Quartermaster to the Corps. In the Los Angeles area about 100 employees were transferred to LAD.

Immediately after Pearl Harbor, the Corps was further assigned responsibility for the construction of all Army projects. Consequently, the District shifted to military works all employees who had been utilized on civil works, except those essential for the operation and maintenance of flood control and harbor structures and a small group for the study and preparation of survey reports. The character of the staff also reflected the changed situation. Many employees exchanged their civilian clothes for military uniforms, usually without much alteration in duties or responsibilities. William J. Leen, with a brilliant 5-year record of achievement as Assistant Chief of Operations, LAD, and with exceptional ability to complete important contracts in the shortest time consistent with sound engineering practice, was now Lieutenant Colonel William J. Leen, C.E., Chief of Operations, LAD, supervising all Army construction in southern California, Nevada and Arizona. He temporarily left the District for duty in the European and Pacific Theaters of Operation. Relieved from active duty early in 1946, he rejoined the District in March of that year as Chief of the Construction Division. For the next 25 years he was instrumental in the successful completion of the Los Angeles County Drainage Area Project, the most extensive flood control project in a metropolitan region; and in the construction of one-of-a-kind space research and launch facilities on the Pacific coast. His outstanding knowledge of engineering and the construction industry, coupled with his high sense of duty and loyalty, produced many imaginative works instrumental in saving lives and property and in advancing the frontiers of space knowledge.

Harry W. Thompson, with 7 years of service in the District, became in 1942 Chief of Engineering with the rank of Lieutenant Colonel, C.E.

After relief from active duty at the end of the war, he remained as the civilian Chief of the Engineering Division until 1962. His knowledge, ability, and know-how in the engineering field guided successfully the progress of the myriad activities within the District. Some others, like Colonel Leen, not content with their roles on the home front, valuable and necessary though they were, moved into various theaters of war, eager to apply directly to the war their accumulated engineering experience.

Other key civilian personnel retained their position of responsibility without military rank. For example, Guy Bebout, rated Head Engineer, was installed as Chief of Civil and Miscellaneous Engineering, LAD, in charge of rivers and harbors, flood control, fortifications, and passive defense, his normal duties, to which were added military ones. Functioning as District Regional Engineer in San Pedro was Harry W. McOuat, a valuable member of LAD since 1920. These men remained vital cogs in LAD for many years after World War II, as did many others.

Furthermore, many retired engineer officers offered their services to the Chief of Engineers. In this category was Colonel Rufus W. Putnam, who returned to active duty as District Engineer, LAD, serving from the 20th of July 1942 to the 1st of February 1946. Colonel Putnam had graduated with honors from West Point in 1913, had seen active service in World War I, and was District Engineer in Chicago in 1926 when he retired. As a consulting engineer, his most noteworthy achievement was his Chicago Report, which became the basis for all future harbor planning of the City of Chicago. A further distinction was the fact that he was a direct descendant of Colonel Rufus Putnam, a Chief Engineer under General George Washington during the American Revolution.

On December 1, 1942, a reorganization of the Corps of Engineers created 11 Engineer Divisions, whose boundaries were adjusted to conform to those of Service Commands of the Army in order to coordinate functions common to Service Commanders and Engineer Division Commanders. The new Pacific Division encompassed the work of the Corps west of the Continental Divide, with headquarters in Salt Lake City, and with Brigadier General Warren T. Hannum as Division Engineer.

Within this Pacific Division was placed the Los Angeles District, whose area, though reduced, still embraced 239,750 square miles. To facilitate operations, LAD was decentralized into eight regional offices: San Diego, Los Angeles, San Bernardino, San Pedro, Santa Maria, Banning, and Riverside – all in California – and Phoenix, Arizona. These regional offices performed practically all the functions previously

performed by the district office. Through telephone, teletype, inspections, and other means of communication the district headquarters supervised closely the activities and progress in each regional office.

With amazing speed and efficiency LAD transformed its area into one great armed camp – the southwestern defense for the country. The volume of work necessitated a huge increase in staff, so that 7 months after Pearl Harbor the District reached a peak of 5,460 employees. To accommodate this large staff, the District leased additional space in several buildings which were near the headquarters at 751 South Figueroa Street, including the Don Lee and Woodbury Buildings.

With Pearl Harbor all construction activities rapidly accelerated. The volume and the diversity of the work accomplished by the District during this national emergency stagger the imagination. Among the major components of construction were Civil Aeronautic Administration projects, sponsored by local governmental agencies; aircraft warning stations for the Air Corps and the Signal Corps; training fields, tactical bases, transport command bases, and cantonments for the Air Corps; alien relocation centers for administration by the War Relocation Authority; prisoner-of-war camps for the Provost Marshal General; training aids of divergent types for ground and air forces; piers and docks, planned and constructed with the Service of Supply; and passive protective measures for military installations and industrial plants manufacturing vital war materials.

The District became one of the major employers of construction skill. For an extended period, construction contracts totaled around $20,000,000 a month, requiring the services of many of the major construction firms in the locality and providing employment for approximately 35,000 persons a month. LAD, along with the other districts, engaged in an intensive, successful recruiting drive in order to obtain men with special working skills for service with Army Engineers in world-wide theaters of war.

Until August of 1943 LAD was solely responsible for the acquisition of an immense mass of real estate required to fulfill its military mission, and it continued this role to a limited degree after that date. Hundreds of thousands of acres of land were leased or purchased. In a significant way the real estate program also turned into an economic benefit to the community. LAD leased or purchased hotels, office buildings, warehouses and other facilities which had become a heavy economic liability to their owners as their activities, unessential to the war effort, were curtailed. Manufacturers and dealers of such restricted products as automobiles and certain machine parts were happy to have the burden

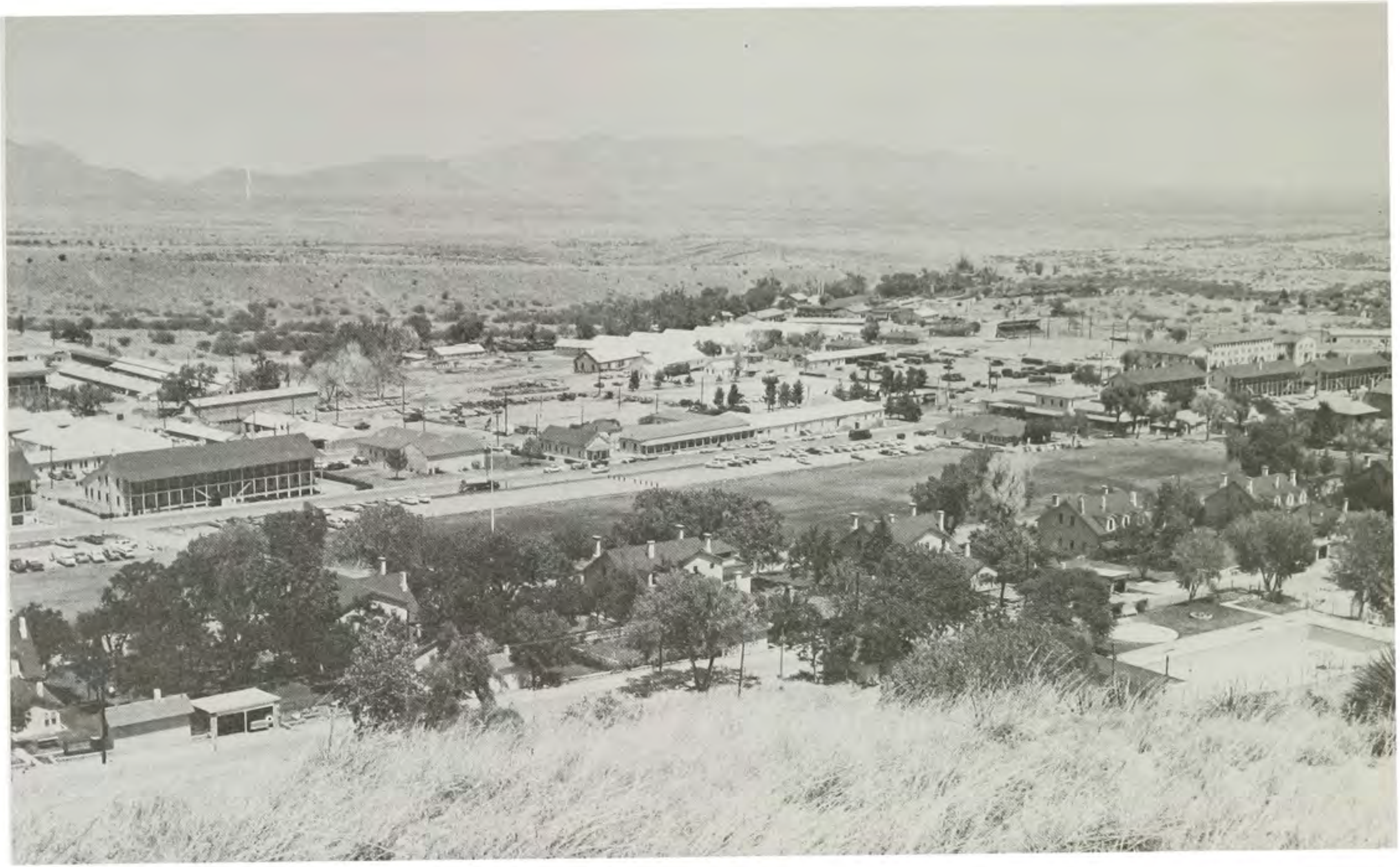
of idle floor space relieved by leasing their property to the Federal Government through the Corps of Engineers.

In contrast to the situation in World War I, the Pacific coast was of paramount importance as the base for conduct of military operations in the Pacific. Moreover, the Armed Forces took advantage of the ideal climate as well as geographic location, to establish training camps with necessary amenities and plants for manufacturing war materials, especially airplanes.

To house the new army of regulars, National Guard, draftees, and volunteers, LAD built 11 major training camps and staging areas over an area reaching as far east as Fort Huachuca, Arizona, as far north as San Luis Obispo, and as far south as San Diego. Each camp had all necessary mess and recreational facilities as well as an adequate camp hospital.

To provide medical care, the District built eight independent hospitals, including three general hospitals and five station hospitals. Of considerable pride to the District was the construction of the Birmingham General Hospital at Van Nuys which represented a unique development in single-story hospital design known as the "Type A Plan," which reduced distances between corners within the hospital

Lower reservation, Ft. MacArthur, California, August 6, 1938.



Panoramic view, Fort Huachuca, Arizona, showing main cantonment and administrative area.

Camp Cooke, California, rising from the barren landscape, November 18, 1941. (Photograph by U.S. Army – Air Corps)

periphery and provided covered walks, permitting travel between all buildings with little or no danger of overhead or ground exposure to the elements.

To store the huge amounts of war materials, the District erected five major warehouse depots, including a $20 million Army Air Depot at San Bernardino and the Army Air Force Supply Depot at Maywood, as well as a Quartermaster Depot and a sizable complex of warehouses attached to the Los Angeles Port of Embarkation.

The expansion of the aircraft industry in southern California, the development of airplanes with the capacity of carrying loads for which special landing fields had to be provided, and the fantastic number of planes rolling off assembly lines necessitated the construction of numerous airports and the modification of many existing civil airports to wartime needs. Through this program LAD made Los Angeles not only the leading seaport but also the leading airport in the West.

Of the more than 100 Army airfields constructed, about 50 percent were training bases, while the balance comprised mostly tactical bomber bases and modification centers. To make them, as much as possible, self-contained units, each facility was provided with mess and recreational facilities as well as other special features. The sites of the airfields were located at points as widespread as the boundaries of the District. As a result of these distances and the wide range of climatic conditions involved, the District encountered extremely complex problems in the location and development of adequate water supplies, the designing of utilities, and the movement of construction equipment and materials. The combined surfaces of runways, taxiways, hardstands (a hard-surfaced area for parking airplanes), and aprons comprised a total area of over 40,000,000 square yards of concrete or asphaltic concrete. This total would be equivalent to a theoretical highway 20 feet wide and about 3,500 miles long, considerably more than the road mileage between Los Angeles and New York. The bulk of this surface also handled the heaviest aircraft flown then.

LAD also made preliminary plans and investigations in conjunction with the government of Mexico for Army Air Corps landing fields and facilities in various locations in Baja California.

At San Diego Harbor, LAD let a contract for the dredging of a seaplane basin 1-1/2 miles wide and 3-1/2 miles long, which upon completion became one of the largest protected seaplane bases in the world, of sufficient size for the training in squadron formation of the largest bombers with full load. In addition to the seaplane basin, portions of the harbor were dredged to provide added anchorage for the

increased number of naval vessels, and areas of land were reclaimed with the dredged material to provide for the expanding needs of the Naval Training Station and the Marine Corps Base.

In Los Angeles and Long Beach Harbors approximately 21,000 feet of detached breakwater were under construction, with the Navy responsible for 6,000 feet and LAD for the remainder. The objectives were to increase the available protected anchorage for naval vessels and to provide an additional shield for naval and commercial facilities on the seaward face of Terminal Island. Large areas lying within the shelter of the breakwater also were dredged 40 feet deep to obtain added anchorage for capital ships. As usual, the dredged material was used for beach restoration and pier construction. This work was completed in 1941. However, work on an additional 13,350-foot detached breakwater at Long Beach was terminated on order of the War Production Board on March 11, 1942. Finally, in 1949 LAD completed this breakwater.

LAD also undertook a modernization program of seacoast fortifications for harbor defenses of Los Angeles and San Diego under emergency and urgent War Department directives.

In addition to improving seacoast fortifications LAD planned, constructed, and maintained other passive protection structures, particularly against the new threat from the air. The District built aircraft warning service stations, consisting of radar station operations buildings, information and filter centers, troop housing, and concealment, which were turned over for operations to the Los Angeles and San Diego Fighter Wings of the Fourth Fighter Command. In addition, the District established a Very High Frequency (VHF) control system, which included fighter control centers, Direction/Finder (D/F) stations, troop housing, and concealment in the South and North Los Angeles and San Diego Fighter Control Areas.

Another responsibility, but by no means a minor one, delegated to LAD was developing and constructing devices for the protection of industrial plants and military installations against possible enemy attack.

Passive protection, camouflage, was utilized on a vast scale to safeguard vital defense facilities. The camouflaging of acres of territory was a task of astonishing proportions. This program called for the construction of 278 separate items of protection at 17 industrial plants, in addition to similar work at military establishments. Besides the actual installation of such protection, LAD developed some of the most modern camouflage materials and methods to come out of the war. A camouflage school also was conducted for the training of hundreds of Army officers (including the author of this history), enlisted men, industrialists, and civilians.

A major factor in the success of the camouflage program was the presence within LAD of T. George Hazenbush. Following his army service in World War I as Second Lieutenant, C.E., he was reappointed as Second Lieutenant in Reserve Corps, 316th Engineers, as Camouflage Officer, 1923, and steadily rose in rank, being promoted to Lieutenant Colonel in 1942. During his reserve duty he had acted as Liaison-Camoufleur between the Engineer Board and the motion picture industry, the latter with which he was associated in an executive capacity for 16 years. In 1941, he was placed on active duty with the Los Angeles District Office as Chief of the Camouflage Section. On reorganization of the Corps of Engineers in 1942 he was appointed Chief of Engineering "C," Passive Protection (camouflage), San Francisco Branch, Pacific Division, another payoff of the traditional national policy of giving army engineers jobs that were both civil and military. The know-how which the motion picture industry developed to persuade the American public to accept what they saw as reality was exactly what the country required to deceive the enemy by converting movie technology into camouflage techniques.

With considerable satisfaction Brigadier General Hannum told representatives of the armed forces, the Federal and State Governments (including Governor-elect Earl Warren), and members of the construction industry on December 11, 1942 that:

"Just a year ago there was a great public cry for action. I am sure the people now feel they have got action. The $20 billion war program I told you about last year became $80 billion. You will be interested to know that the work as a whole has gone along on scheduled time, presenting the greatest construction achievement in our history."

The major contributor to this success was the Los Angeles District.

In their excellent, detailed study of the engineers in World War II, *The Corps of Engineers; Construction in the United States,* Lenore Fine and Jesse A. Remington recorded the congratulations the Los Angeles District received for their remarkable accomplishments. They cited the explanation of Lieutenant Colonel Kelton, who commented: "The real answer to our ability to turn out plans and specifications consists of the fact that we are just plain 'damn good.'" Adding, "I was fortunate in having a large organization of highly trained men with qualifications to handle almost any type of construction. This of course was the secret of being able to get started early on these jobs."

Fine and Remington noted that in order to conserve all building materials Brigadier General Thomas M. Robins, Assistant Chief of Engineers, ordered "lowering safety factors; taking over hundreds of

hotels and apartment houses; making greater use of masonry; and, over the objections of the Surgeon General, double bunking barracks." In lowering safety standards the Corps gambled and ignored incidents as the one at Fort MacArthur, where several structures collapsed when 14-inch railway guns fired test volleys there in the spring of 1942. These structures, built in an earlier period, were much stronger than the new ones under construction. But the gamble paid off, for the new structures lasted for the duration of World War II.

Fine and Remington also noted the contribution of the Los Angeles District in the resolution of one of the most difficult missions handled by the Corps of Engineers during World War II, the design of bases for very long-range bombers. The first-hand experience of the District with the problem contributed to the development of the technology "required for super-airports for which there were few engineering guidelines." When the XB-19 (B-19), fabricated by the Douglas Aircraft Company in the spring of 1941, rolled out of its hangar at Clover Field, on hand to observe and report on the event were Colonel Kelton and the District staff. Colonel Kelton reported on the severe damage to pavements then, and on June 27. The experience demanded research. Promptly the Corps organized all its resources and supplemented these with specialists from the outside to come up with a solution. Studies at the Waterways Experiment Station, Vicksburg, Mississippi, and tests and experiments by district offices throughout the country produced the fund of knowledge which not only resolved the immediate problem of constructing airfields for the new monsters of the air but also pioneered a new technology, which established a new chapter in civil engineering. Among the contributors was the Los Angeles District with its detailed report on pavement performance under the XB-19, which verified the new theory of winglift, whose application to airplanes markedly reduced the stress on runways.

From time to time, LAD was allocated missions of an unusual and demanding nature which also offer excellent clues as to how rapidly events were moving. One example involved a peremptory order by the flamboyant General George S. Patton. Early in 1942 the General arrived in the District to select a site within which to train the 1st Armored Division. His reconnaissance led him to choose the middle of the California and Arizona desert as his preferred site. Upon departure, in characteristic Patton fashion, he stated that he would return with his division and its support personnel, consisting of approximately 60,000 persons, in 40 days, by which time he expected facilities for quartering and messing these men. Upon arrival the troops found the facilities available.

Another example of emergency wartime construction, from the standpoint of magnitude and speed, was the conversion of the Santa

Anita Race Track into a huge refugee evacuation center for the Japanese-Americans, both issei and nisei. The order from Washington for the evacuation and segregation of these residents of the Southwest created an immense housing problem, demanding immediate solution. Quickly the race track was selected as the site for one of the principal evacuation centers. Since the time element precluded formal contract letting, LAD made verbal arrangements with a reputable architect-engineer contractor, Mr. Stiles Clement, to begin the job. As always, the objective was to get the job done.

First construction operations began on Saturday, March 21, 1942. Just 29 days later, April 18, 1942, the project was complete. Moreover, prior to that date many evacuees were accepted. In that brief period, an unheard of feat had been performed. The stable area was converted into an apartment complex, kitchens were provided to furnish nearly 60,000 meals a day, seating accommodations in mess halls totalled over 8,000, and a hospital was built. Also constructed were a laundry building, a drying yard, a giant shower building, a post office, a 6,420-gallon water heating tank, a huge refrigerator, a fire station, a canteen, a loading dock, a warehouse, and facilities for the Military Police assigned to guard the evacuees. Complete drainage, toilet facility, and utilities were included. Originally planned for 15,000 people, the final project housed over 20,000. Among the most appreciative were the evacuees, bewildered though they were by what had happened to them.

In addition, LAD built relocation centers, prisoner-of-war camps, ordnance depots (one of which covered about 35 square miles and included 125 miles of roads and approximately 14 miles of railroad track), and reception centers as well as harbor defenses, fortification, searchlight batteries, anti-aircraft stations, and Western Command posts.

During the 4 years prior to June 1944 over $1/2 billion was expended on military construction in LAD alone, probably more money than was spent in the Pacific Division's five other districts. Within LAD expenditures on military construction varied from $1/2 million per month during the fiscal year 1941 to nearly $28 million per month during the peak fiscal year of 1943. LAD and the other districts proved that military victory on the war fronts depended on success on the home front.

Besides all its other missions, LAD had a supply mission: to produce materials and supplies for overseas shipment to various agencies, including Combat Engineers, Construction Engineers, and other subdivisions of the Armed Forces. The District also purchased, inspected, and repaired heavy-duty construction and other related equipment for overseas use of the Corps of Engineers. Generally, around 150 employees were assigned to this mission.

LAD executed other war-time activities. About the middle of 1942 the Corps of Engineers was assigned the task of constructing the Pan American Highway from the Mexico-Guatemala boundary to Panama. The feasibility of this project of an overland route to Panama depended on the critical international situation and the distinct possibility of an attack by foreign powers on the Panama Canal. Ironically, it took a war to revive the dream of a road connecting the North and South American continents. Besides providing a safe overland supply route to the Panama Canal, the road would aid the economic development of Central America with resulting business opportunities for North Americans. It would also promote friendlier relations with the Central American governments and people, and make a beautiful and romantic region accessible to residents of the United States. The latter reason made the project a very popular one in the United States.

On the 18th of June 1942, Colonel Kelton was appointed Director of the Pan American Highway Survey in addition to his other duties. In view of the importance of the project at this stage of the war, on July 16, 1942, Colonel Kelton was relieved as District Engineer and appointed Director of the Pan American Highway, with the rights and prerogatives of a Division Engineer, and was instructed to make an all-out effort to complete the project by the 1st of May 1943. With his record for accomplishing everything but the impossible as District Engineer in Los Angeles, his appointment appeared to guarantee that the pioneer road would be completed.

Col. E. C. Kelton (third from the right) and some of his staff, including Capt. Yount, formerly with the Los Angeles District, at a camp on the Pan American Highway, March 1943.

Map of Central America, showing the route of the Pan American Highway.

LAD still assisted Colonel Kelton in such matters as supply and personnel recruitment. In fact, many of the 50 officers and most of the 200 civilian personnel were furnished by the Los Angeles District, including Lieutenant Colonel Harold E. Spickard, Captains Harold Jack Yount, L. R. Swartz, Richard Altman, Frederick R. Cline, and many others. In spite of the high qualifications of Colonel Kelton and his staff, their mission was aborted by factors beyond their control, especially the difficulties of operating under the jurisdictions of foreign countries and the fact that ultimately the priority assigned to the project was the lowest given to any work by the War Department. Thus in late 1943 the Pan American Highway project was phased out, and responsibility for termination and final settlement of the contracts was assigned to the Los Angeles District. As an added obligation, the District performed an unusual task.

In 1945 a famous radio commentator made a series of vitriolic broadcasts attacking the project. To determine the validity of the accusations, the Chief of Engineers ordered an exhaustive historical monograph, with a secret classification, to be prepared by LAD. The latter turned over the task to Frederick R. Cline (deceased), who had served both as a civilian and as an officer on the project. He also prepared the Final Project Report. In an amazingly short period of time, he produced a complete and authoritative monograph which refuted the allegations. Later, as Chief of the Design Branch, LAD, he not only recalled that difficult chore but also looked back at a long record of distinguished service to the District and the Corps of Engineers.

On the basis of public documents and personal recollections Cline made the following observations. The original plan was to provide an all-weather gravel-surfaced road from the United States-Mexican border to Panama City, Panama, 1,559 miles in length. Upon the Corps the Federal Government placed the responsibility for the project. Mexico promptly withdrew from the project, but the six republics of Central America – Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama – participated. The withdrawal of Mexico shortened the route to 1,245 miles, of which a survey revealed only 336 miles as satisfactory for all-weather travel. Of the remaining 909 miles which required either major rehabilitation or complete construction, the Corps was assigned 826 miles, leaving a mere 83 for other agencies. At the supension of work late in 1943, Colonel Kelton and his staff had brought up to the criteria of an all-weather road 641 miles, or approximately 80 percent of the original assignment. Within a few months after the departure of the Corps, Costa Rica continued work to make another 70 miles passable at all times. However, the remainder, 115 miles, from San Isidro, Costa Rica, to the Rio Chiriqui Viejo, Panama, still consists of rugged terrain.

In their interim report on the highway the Committee on Roads, House of Representatives, 80th Congress, pursuant to House Resolution 255, 18 December 1946, "found that credit should be given to the Corps of Engineers for the field job done in locating and constructing the road and completing 58 percent of the assignment under the almost prohibitive limitations placed on the project by the low priority and lack of shipping space." Moreover, it did "not feel that the mistakes in adminstration and management should be allowed to detract from the splendid and loyal work done by the many men and officers under extremely primitive working conditions in their actual procession of the job at the job site. . . . Furthermore, the alignment selected by the War Department was found to be practical from the Army operational viewpoint." While these conclusions did not still criticism, they did elevate the nature of this discussion.

When the Corps of Engineers received the vital mission to develop the atomic bomb, following standardized procedures it established the Manhattan District, which had the usual privilege of calling upon the other districts for assistance. For example, LAD participated in the nation-wide search requested by the Manhattan District to select the best locations for atomic development sites, which turned out to be Oak Ridge, Tennessee and Richland, Washington (Hanford Works).

On February 23, 1944 the Los Angeles District received an unusual assignment, "to take possession of and operate the entire properties of the Department of Water and Power for the City of Los Angeles in California and Nevada." With 160 plants engaged in war production idled by the refusal of striking power workers to repair power lines broken by a severe rainstorm, President Roosevelt at the recommendation of the War Department had ordered the takeover of the strikebound utility. At 10:45 A.M. of the 23rd Colonel Putnam and his staff assumed charge of the organization, ordered the employees back to work which they did with alacrity, inaugurated 12-hour shifts, and announced on the 25th that electric services had been restored to "all vital war industries" and to "the greater majority of local consumers excepting a few isolated homes." For this achievement, Colonel Putnam praised the employees whose zeal and efficiency produced this fine result. Six days later, after careful consultation with key management and labor officials, Colonel Putnam relinquished control of the utility. Continuing pressure from the Federal Government resulted in a satisfactory resolution of the management - labor problem by March 15, 1944.

In addition to the above activities, LAD performed studies and prepared 50 major military reports at the request of other agencies. These reports included:

a. Survey reports for passive defense at vital industrial facilities, including refineries, shipyards, and munitions and aircraft plants.

b. Supplemental reports to reports prepared by other governmental agencies (including a report on a butadiene plant).

c. Reports on existing facilities at essential industrial plants (requested by Defense Plant Corporation (DPC), AAF-Materiel Command, and others).

d. Report on investigations of water supply at Vernon and Burbank for fire protection.

e. Report on protection of Los Angeles Harbor from oil spills. (An early indication that the Corps of Engineers was aware of environmental problems.)

f. Test to determine adequacy of bomb-resistant structures, with a report to the Office of Chief of Engineers.

g. Semi-annual reports on water supply for San Diego, to insure that future requirements would be known well in advance of actual need.

h. Reports on study of a second entrance to San Diego Bay.

i. Report on study for a tunnel under San Diego Bay, San Diego to Coronado.

j. Report on study for a tunnel under Long Beach Harbor entrance channel, Long Beach to Terminal Island.

With the war, many functions which were formerly considered to be of a strictly civil nature, especially such civil functions as flood control and harbor improvement, proved invaluable to national defense.

The harbors at Los Angeles - Long Beach and San Diego served as major naval bases, major shipbuilding centers, and ports of embarkation for the movement of troops and war materiel to theaters of operations as well as handling large volumes of commercial tonnage.

Small craft harbors like Newport Beach, Port Hueneme, and Morro Bay served very useful purposes as harbors for all branches of the Armed Forces. Small craft repair facilities were expanded to build and repair small naval craft.

Like the harbors, flood control projects proved their value by providing vital protection for the major war industries, as well as important military and naval establishments, in southern California, thus enabling uninterrupted operation of these industries in times of excessive rainfall and subsequent floods. The value of flood control improvements in the Los Angeles River Basin was demonstrated in the spring of 1943. At this time, the volume of inflow into Hansen Reservoir was greater than the great flood of March 1938. Thus, while the uncontrolled 1938 flood caused heavy loss of life and severe property damage in the Los Angeles area below Hansen Dam, the 1943 flood was controlled by the dam, which probably saved many lives and made possible the uninterrupted operation of war plants in the area.

World War II proved the effectiveness of LAD to assist in providing national defense, for under Colonel Putnam (20 July 1942 - 1 February 1946), the Los Angeles District produced a record of achievement in military construction that probably was not surpassed by any other district in the Corps of Engineers.

At the end of World War II, in keeping with American tradition, the American people, oblivious to the ambitions of the Soviet Union, forced a rapid, undesirable demobilization. With the decline in the size of the Armed Forces, the support structure on the home front also was dismantled. The Corps of Engineers, having had responsibility for construction on the home front, also would be involved in the dismantling process.

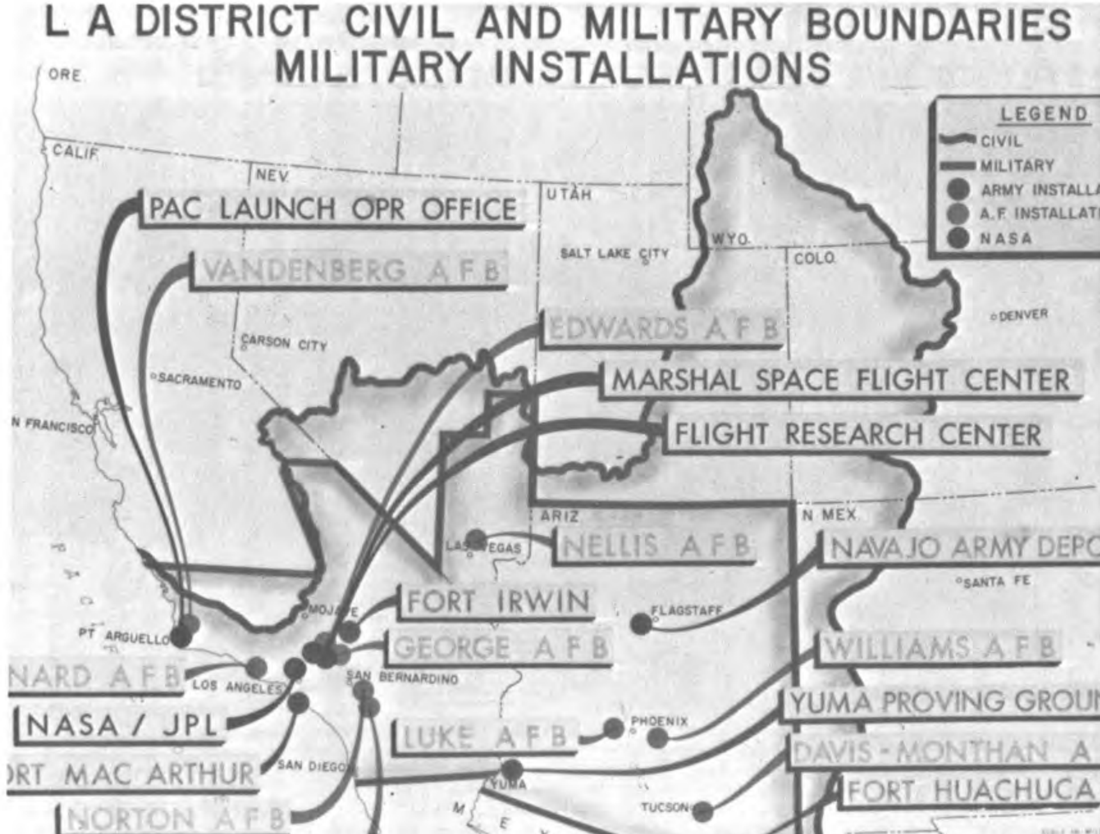
Thus the Los Angeles District now confronted many problems presented by the custody and protection of closed installations. Privately owned facilities which had been leased were returned to their owners. Other closed installations were maintained and guarded for over a year until they were transferred to the War Assets Administration.

Among the installations no longer necessary for the Armed Forces was the California-Arizona desert maneuver area. During their training exercises the troops had used live ammunition, of which a certain

amount lay unexploded throughout the vast area. To protect the public, this land had to be cleared of these dangerous explosives. On LAD's shoulders was placed the responsibility for this hazardous mission. Promptly and efficiently, personnel of the District trained dedudding teams which made the area relatively safe by removing the unexploded shells and bombs. Warning signs were posted to keep the public out until the task was completed. Tons of battlefield scrap also were collected and ultimately disposed of by burial at sea. Nevertheless, LAD still returns to the area for further operations. For example, in 1957 the District enabled a company to construct a 16-inch crude-oil pipeline from the Four-Corners area of the States of Utah, Colorado, New Mexico, and Arizona to refineries in and near Los Angeles. The District cleared a 50-foot wide strip for approximately 15 miles through a portion of the former California-Arizona Maneuver Area. To accomplish the mission, visual inspection and mine detectors were used.

Both the Cold War and the Korean emergency exercised a profound influence on the military mission of the Corps of Engineers. Particularly, with the decision to send American troops to Korea, a new sense of urgency quickened the pace of military activities for the Corps. Once again LAD was diverted from its civil works mission to meet the challenge of the international situation. Personnel were transferred from civil works to reopen closed installations and to rehabilitate facilities at all military establishments. Work was accomplished speedily at Forts Huachuca and MacArthur; Camps Cooke, Irwin, and San Luis Obispo; Navajo Ordnance Depot; and airbases. But as Lieutenant Colonel William R. Shuler, District Engineer, pointed out in May 1951, the new construction program for defense now included many activities not even dreamed of during World War II. In addition to the normal types of facilities – buildings, cantonments, forts, camps, airbases, and industrial plants – the construction program included new facilities such as radar fences, global communication structures, ground-control approach systems, instrument-landing systems and navigational aids, and complex high-speed systems to move gasoline and other fuels and for lubricants. To house many of these components taxed the engineering ingenuity of all concerned. In "un-zippering" the standby World War II plants and installations and rehabilitating them to resume production, the District also had to resolve structural problems.

However, these strictly military phases were only part of the picture. The Cold War influenced the development of a new military technology which would tax the economic resources of the country and constitute a direct threat to the security of the American people. The creation of the Atomic Energy Commission and the Civilian Defense Program portended new challenges. The latter program alone posed new and unprecedented questions such as the types of structures required for the dispersal of the population and of plants.



Military installations at which the Los Angeles District had responsibility for military construction.

LOS ANGELES Reserve District Engineer Office Unit (Engineer District Office, Detachment 1, 9809th ORTSU), left to right; FRONT ROW—Sgt. Van Antwerp, Lt. Col. Henry Kilian, Lt. Col. Charles Phillips, Lt. Col. Moody, Lt. Col. James G. Jobes, Col. Harry W. Thompson (commanding officer), Lt. Col. Jack Blevans, Lt. Col. Everett W. Watkins, Lt. Col. Oliver H. Ochsner, Lt. Col. Richard Altman. MIDDLE ROW—Maj. Robert McKenzie, Maj. William T. Guy, Maj. Douglas R. Woodward, Maj. Edward Koehm, Maj. Lyman A. Markel, Maj. Charles T. Johnston, Maj. Charles E. Mendenhall, Maj. Burnett C. Turner, Maj. Alfred I. Switzer, Maj. Charles E Chowenhill, Maj. Eugene Spencer. BACK ROW—1st. Lt. Roland W. Browne, Capt. Carol C. Roper, Capt. James C. Seasholtz, Capt. Selden F. Cramer, Capt. Samuel Tucker, Capt. Frederick R. Cline, Capt. Roberto Almanzan. Not shown in picture are Maj. Kenneth P. Peel, Maj. James W. Dunham, Capt. James W. Davison, Capt. John W. Strasser.

Los Angeles Reserve Engineer District Office Unit, members of which came from the staff of the Los Angeles District. (Southwest Builder and Contractor, May 11, 1951, p. 37)

Happily, the Corps of Engineers had created a far-flung organization accustomed to handling such problems. Moreover, that organization was highly decentralized. If necessary, new districts could be added as the need arose in the country or overseas, as a result of the intelligent program of establishing Army Reserve Officer units with the know-how to administer such districts. One such unit was in LAD, composed of executive engineers in Federal agencies and private industry with its commanding officer, Colonel Harry W. Thompson, also Chief of the Engineering Division.

By working together for years the Corps of Engineers and the civilian construction firms made an excellent team to get things done. For example, in January 1951 over 100 different major contractors were under contract with the Los Angeles District on military construction. Colonel Shuler expressed appreciation for the high order of workmanship demonstrated by the contractors in meeting the needs of the military construction program. He considered them outstanding examples of the "American Way" in getting jobs done. Many projects were placed in the District to take advantage of its strategic location and certain desirable climatic features, which meant that much of the military engineering design in the District was for projects of a highly specialized or technical nature. In an amazing turnabout, the American people demanded a strong defense structure with the hope of deterring World War III. Under this military construction program, an astonishing number of important projects were undertaken which deserve special mention.

An outstanding example of the changing nature of the military mission of the Los Angeles District was the creation of the United States Air Force Flight Test Center out of the old Muroc Base of World War II, better known as the Edwards Air Force Base. A unique combination of nearly perfect flying weather, isolated location, and natural airport made the area ideal for a test center. To supplement Rogers Dry Lake with its glass-like surface, capable of supporting heavy aircraft, the District designed and had built a 15,000-foot runway which formed a flight-landing area 22 miles long – the longest runway in the world. Besides the ordinary routine of an airbase, the center supported a multitude of mysterious activities. Numerous organizations, governmental and private, tested and evaluated new airplanes, including the famous X-15 in 1960, and rocket engines. In the Space Age, Edwards would remain an ideal test center.

To allow for complete use of the dry lake region, LAD relocated 36 miles of the Santa Fe Railroad. As part of the task the District acquired mud mines which provided mud for oil well drilling. These mines were then filled in to provide a sound foundation for the relocated track. In

addition to new runways, taxiways, and relocations the District designed and constructed all sorts of facilities. Another task that called for considerable skill was the moving of two huge steel hangars. In 1954 another unusual project required the movement in an erect position of a 500,000-gallon and 65-foot high elevated water tank a distance of 7 miles. The nature of the job produced safety problems which were resolved by George Arndt and "Doc" Gurney. For years the District would be involved with meeting the needs of the Edwards Air Force Base.

In southern California other bases at which the Los Angeles District achieved major construction work included March Air Force Base at Riverside, Norton Air Force Base at San Bernardino, George Air Force Base at Victorville, and Oxnard Air Force Base.

In Nevada the District refurbished Nellis Air Force Base which paid off dramatically, for this base had the distinction of producing practically all the Sabre jet pilots for the Korean War. Another key defense feature in that area was the construction of the Nellis Ordnance Storage Area, one of the finest and largest in the country.

In Arizona, one of the largest construction programs for the Los Angeles District in that state was underway after the outbreak of the Korean conflict. For the Air Force, the District worked on Luke Air Force Base at Phoenix, Williams Air Force Base at Chandler, Davis-Monthan Air Force Base at Tucson, and Yuma County Airport at Yuma. Reactivation of Luke Field as a fighter base in February 1951 reestablished what had been the biggest Air Force training base for fighter pilots during World War II. The original project was executed with remarkable speed by the District. Orders for construction were issued on March 24, 1941 and by June 1 of the same year the first airplane landed.

Unfortunately, Luke AFB in the Agua Fria area was hit periodically by floods. Thus, in 1951 the base was completely inundated; silt, sand, and gravel were deposited over the entire base and about 200 buildings were flooded. Moreover, the town of Goodyear, the Litchfield Park Naval Air Facility, and valuable agricultural lands also were flooded. The urgency of the problem was known, but the financial difficulties prevented a solution. Finally, in 1953 Congress permitted the Secretary of the Air Force to authorize a flood control project, Trilby Wash detention basin and outlet channel. In 1966 LAD completed the project which protected not only the Air Force Base, but the Litchfield Park Naval Air Facility, the Goodyear Aircraft Company plant, the towns of Goodyear, Litchfield Park, and Avondale, and about 50,000 cultivated acres of agricultural lands.

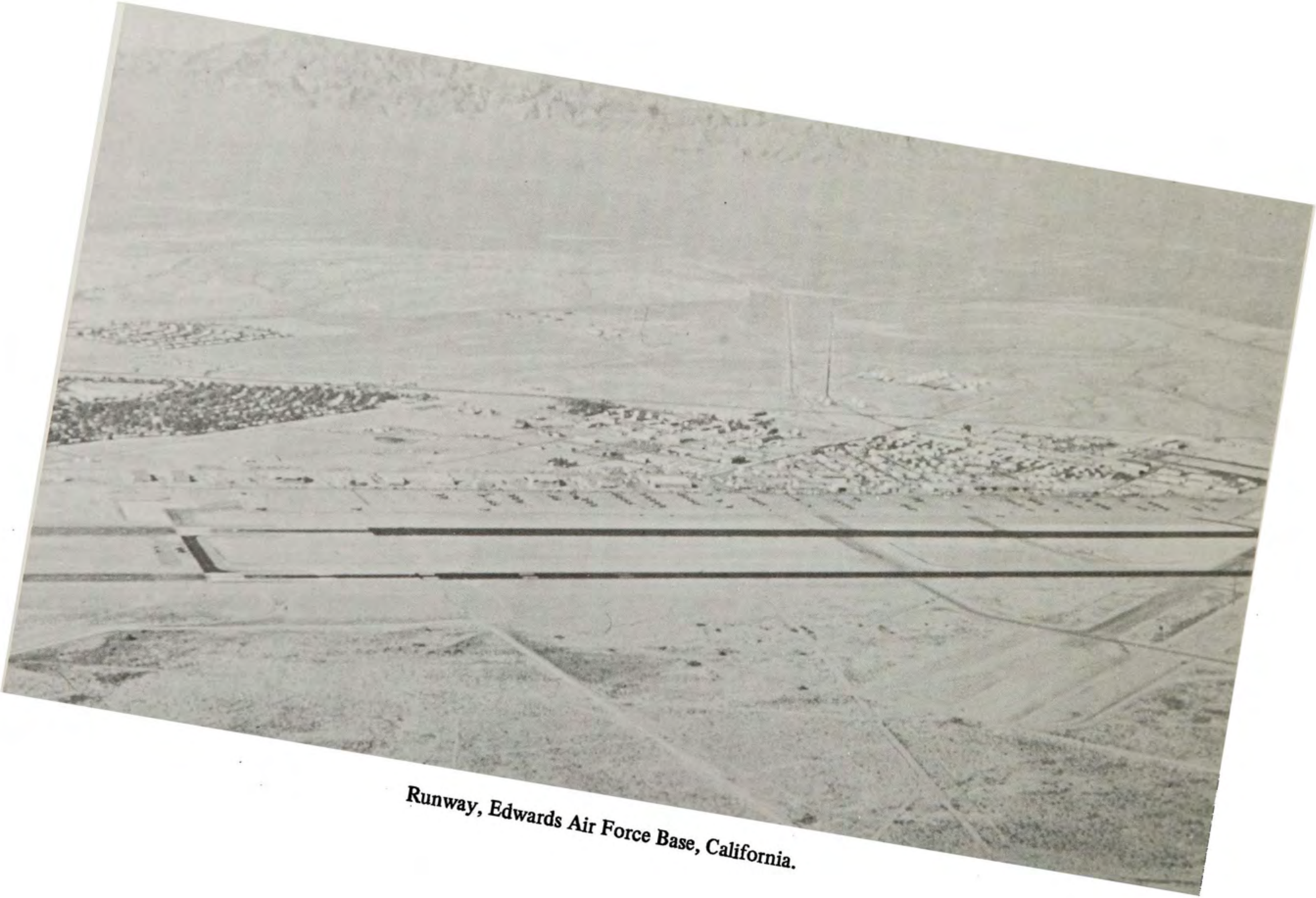
Of importance to both Luke and Williams AFB's was the Gila Bend Gunnery Range, the acquisition of which kept the Real Estate group in LAD busy. LAD established the range with 2,776,423 acres, located 78 miles southwest of Phoenix in the Yuma Desert. In training missions pilots daily subjected this area to blasting rockets, bursting bombs, burning napalm, and ripping 50 caliber machine gun slugs. Its value in pilot training was demonstrated during World War II and the Korean fighting.

The construction mission of the District for the Army, although smaller than that for the Air Force, also expanded significantly after 1950 with the work at the reopened facilities. The District was also assigned responsibility for construction of disciplinary barracks at Lompoc; Army reserve armories in Pasadena, West Los Angeles and Santa Barbara; and the Jet Propulsion and Rocket Laboratory (JPL) at California Institute of Technology. Considerable improvements were made at the Yuma Test Station, a major research and development installation of the Army. Out of the remains of Fort Huachuca in Arizona the district created a new research and development center, the Army's Electronic Proving Ground (AEPG). The cavalry which occupied Old Camp Huachuca in the days of Geronimo would never recognize the site.

Military construction contracts included U.S. Army Reserve Training Centers, target intelligence training buildings, officers quarters, service clubs, enlisted men's barracks, dormitories, dining halls, armament and electronics shops, Capehart and Wherry housing, technical buildings, electrical distribution systems, sewage treatment plants, wash racks, hangars, airfields, taxiways, jet test cells, squadron headquarters, storm drainage systems, roads, water wells, utilities and innumerable other items.

In 1956 Colonel Arthur H. Frye, Jr., District Engineer, estimated that the military construction program of LAD was probably at its greatest peak since World War II. He also observed somewhat ironically that this program was once considered a temporary workload, yet since 1940 the District carried this extensive load for 11 of the 16 years. Under his command were 1,159 employees, an indication of the huge workload of the District. He predicted that unless an unforeseeable miracle occurred no one could prophesy when this so-called temporary work would end. Not until the latter part of the 1960's would there be a slackening in military construction.

Since 1950 the military construction workload had averaged from \$50 to \$100 million per year, generally at the latter figure. Obviously, this program had economic implications for southern California,

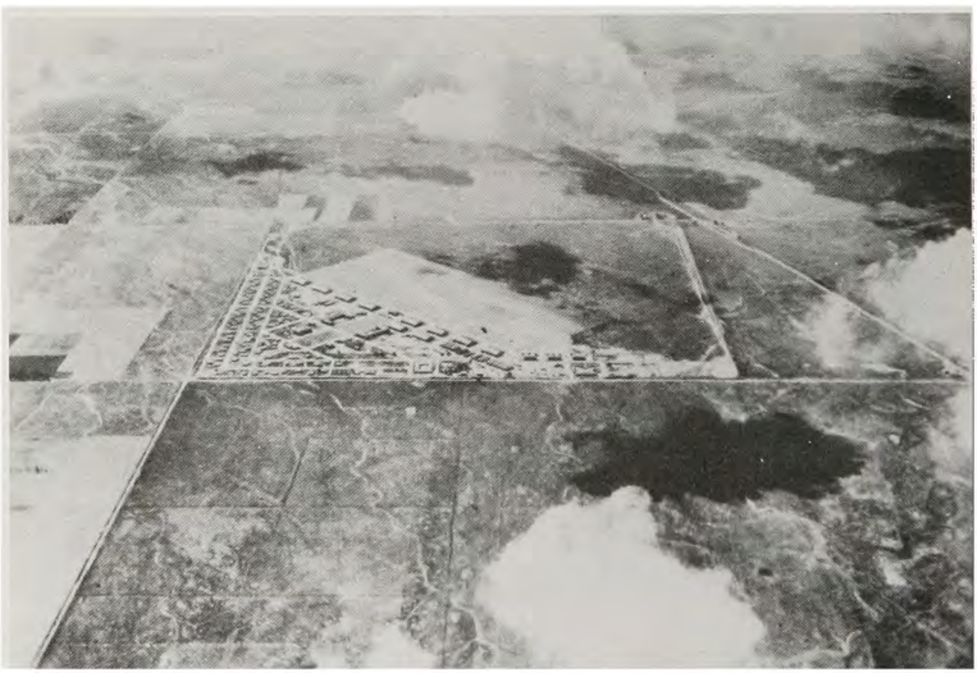


Runway, Edwards Air Force Base, California.

Pouring concrete for taxiway, Edwards Air Force Base, California, August 1955.

Completed hangar, Edwards Air Force Base, California, August 1955.

March Air Force Base, 1918.



March Air Force Base, 1937.

March Air Force Base, 1949.

TYPICAL MILITARY FACILITIES CONSTRUCTION IN THE 1950'S AND 1960'S

Airmen's dormitory, dining hall, Davis-Monthan Air Force Base, Arizona (1958).

Bachelor Officers' Quarters, Yuma Test Proving Grounds, Arizona.

Capehart Housing, Yuma Test Proving Grounds (1958).

Chapel, Yuma Test Proving Grounds (1966).

Two-hundred bed hospital, March Air Force Base, California (1964).

Arizona, and southern Nevada. Not only did the program mean much to the construction industry, but also to the economic livelihood of the region. The purchasing power of thousands of military and civilian personnel at these installations generated even greater influence on the economy of the region.

The rapid deterioration of the international situation in 1948 also had prompted the decision to undertake a speedy expansion of the air defense of the United States. The Corps of Engineers participated in both the defensive and offensive aspects of flight. At this time, LAD concentrated on air defense. Radar sites and special warning installations, coupled with guided missile batteries, were constructed as the major components in the passive defense program. Offensive aspects were not mentioned.

The Los Angeles District also engaged in the preparation of sites for ground-to-air guided-missile type of anti-aircraft installations under varying climatic, geographic, and human conditions. In February 1955 the Office of the Chief of Engineers praised the District for the zeal and effort displayed in the expeditious prosecution of the NIKE program for the Los Angeles Defense Area. One such problem encountered and overcome by LAD was the transport of water for compaction and concrete to the Mount Gleason site, from a source 15 miles away. By 1960 the District had assisted in the advance of air defenses from NIKE AJAX to the nuclear-capable NIKE HERCULES. Thus a ring of supersonic steel protected greater Los Angeles from a surprise attack, making it the most thoroughly defended area on the west coast and on a par with any in the nation. The District also participated in the design conference for a Missile Master to coordinate all elements of anti-aircraft defense from target detection to target destruction.

Advances in missile development in the 1960's rendered these defense structures obsolete. Consequently the District had to dismantle these defenses and dispose of the sites.

In 1958 LAD was assigned responsibility for the design and construction, as well as the acquisition of real estate, for HAWK (Homing All the Way Killer) for the Los Angeles and Vandenberg Air Force Base Defense Areas. At air bases the district also supervised the construction of SAGE (Surveillance Air-Ground Environment) which was a part of the national defense effort to deter attacks by enemy forces. These structures were further strengthened with Aircraft Control and Warning (ACW) systems at all Air Force bases.

With the advent of SPUTNIK (1957) the tempo of work in the Los Angeles District speeded up considerably on the ballistic missile

program, for, even before American defenses based on strategic aircraft were completed, technological progress had overtaken the long-range bomber. With the development of the intercontinental nuclear missile, which could devastate any nation in one concentrated attack, came a powerful stimulus to reshape military defense against the nuclear missile.

Furthermore, the Corps of Engineers assumed the primary responsibility to construct for the Air Force certain of the technical and operational facilities for the intercontinental ballistic missiles (ATLAS and TITAN), intermediate range ballistic missiles (THOR and JUPITER), and associated weapons systems, located both in the continental United States and in applicable overseas areas.

For its part the Los Angeles District converted a deactivated military reservation known as Camp Cooke into a monumental missile and space center, Vandenberg Air Force Base. This site was selected by the Air Force after careful study of some 200 possible locations. Besides the strategic advantages of fronting the Pacific Ocean and possessing a built-in safety feature – isolation from population centers – Camp Cooke also enjoyed the advantages of proximity to the aerospace industry and experienced architect-engineer construction firms in southern California, site ownership by the Federal Government, and, not least, of LAD's remarkable record of accomplishing difficult missions.

Camp Cooke was transferred from the Army to the Air Force on June 7, 1957 and renamed Cooke Air Force Base. To commemorate a distinguished air pioneer, General Hoyt S. Vandenberg, the Air Force changed the name to Vandenberg Air Force Base on October 4, 1958. Under the leadership of several district engineers, primarily Colonels C. T. Newton and William T. Bradley, LAD served as the supervising construction agency with added responsibility for design and construction of support facilities for the missile program. The Army Engineers in the South Pacific Division in close liaison with the Air Force installation's representative reviewed missile design criteria to insure acceptability for construction.

In the spring of 1957 LAD initiated the process of converting the deserted, windblown, paint-peeled Army training base of World War II and Korea into a major center of defense and research for the Space Age. Fittingly, among the long-term civilian vanguard was Bill Starrett, who in 1941 assisted in putting up the first buildings at Camp Cooke, on a rugged plateau previously known as the Burton Mesa.

Since this missile base was designated as a combination training, research and development, and operational base, its design features were different from those at Cape Canaveral (renamed Cape Kennedy), in

Florida, where the Corps of Engineers gained its initial experience in missile base construction. Rapidly, facilities for long-range ballistic missiles – the THOR, ATLAS, TITAN, and MINUTEMAN – made their appearance. There arose or were sunk missile assembly buildings; facilities for generating liquid oxygen and storing missile fuels; an airfield to fly in supplies expeditiously; launching pads, each specially designed for a given type of missile; blockhouses to protect personnel and equipment; guidance and tracking stations with associated antenna fields.

In 1958 a new breed of fighting men, the "missilemen," arrived as part of a new organization – the First Missile Division. With the cost of training these specialized technicians so high, the Air Force spent considerable sums to make them comfortable and happy, hoping that they would become career men. Instead of living in tarpaper shacks, these specialists lived in Capehart housing, in rooms comparable to those in a good hotel. Thus LAD built a modern impressive military city which reflected to the missile technician the importance of his mission.

By October 2, 1958 over 40 contracts had been awarded, valued at over $50 million. To supervise execution of these contracts, the District first established a project office at the base under Bruce Bennett. Because of the great scope and importance of the construction program, Colonel Newton raised the project office to the status of an area office under Lieutenant Colonel Allen W. Sanders, Jr. For outstanding work as Western Area Engineer for LAD, Colonel Sanders was awarded the Air Force Commendation Medal.

This area office worked closely with the Air Force Ballistic Missile Division at Inglewood, California, and with the civilian contractors to complete the design and construction of the Vandenberg Air Force Missile facilities as rapidly as possible.

By 1968 Vandenberg AFB was a community sprawling over approximately 98,000 acres, making it twice the size of Washington, D.C., and consisting of a population in excess of 28,000. The base has 36 miles of coastline and contains 327 miles of paved roads, 1,076 buildings, 1,983 family housing units, and 797 trailer spaces. The distribution lines for electricity cover 534 miles both overhead and underground, while those for natural gas cover 73 miles and delivered over one billion cubic feet of gas during the fiscal year 1967. In that year, the base also used 2,032,506 gallons of water which were treated at the base water plant.

In many respects the construction of these facilities at Vandenberg was no more complicated than construction at other facilities built by

Army engineers, facilities ranging from NIKE sites to chemical plants to hydroelectric dams. It was complicated by the telescoping of time and the need to design and construct the facilities concurrently with the development of missiles themselves. Other difficulties arose from the fact that most of the installations were built underground and had to be designed to withstand the overpressure, ground shock, and radiation associated with nuclear explosions. Probably the most difficult problems arose from the processes involved in the propellant loading systems. These systems were designed as automatic systems with mazes of control valves, regulators, instruments, expansion joints and automatic controls. Each subassembly of every component had to be cleaned, inspected, tested, exactingly installed, retested, and then maintained in a clean state until a facility was completed and turned over to the Air Force for operation. This phase of their activities required constant surveillance by the staff of the area office.

The "hardening" of facilities to withstand ground shock and air overpressures from a near atomic blast created many unique engineering problems. One problem involved the proper design of blast-resistant doors to the missile silo as well as resolving construction difficulties in placing these blocks of concrete. The engineers solved these and other problems, and so helped to establish Vandenberg AFB as an arsenal of strategic importance.

In carrying out its responsibility to construct for the Air Force the technical and operational facilities for the ICBM, IRBM, and associate weapons systems, the Corps of Engineers experimented with different organizational arrangements before arriving at an ideal one. The design of Air Force ballistic missile facilities was highly centralized: it was under the jurisdiction of the Air Force Ballistic Missile Division (AFBMD) at Inglewood, California. Since direct communication was required between AFBMD and the Corps of Engineers, the Chief of Engineers logically designated the Los Angeles District as the primary agent for coordination and liaison with AFBMD and for review of AFBMD designs for construction feasibility.

To carry out its review function, LAD established a Special Projects Branch. In July 1958, in recognition of the increasing scope and importance of the ballistic missile program, Colonel Newton created a special office in LAD: The "Corps of Engineers-Air Force Ballistic Missile Office." Responsibility for coordination and liaison with the Air Force in the planning and engineering review of technical facilities was placed in the hands of a special team of experienced design reviewers. Further, to facilitate the solution of mutual problems, the office was physically adjacent to the AFBMD. This move emphasized the

teamwork between the Air Force and the Corps of Engineers that would get the job done. In addition, CE-AFM Office became a central source of information for other divisions and districts of the Corps of Engineers concerned with the construction of missile facilities. However, the Cold War intensified as a result of the bringing down of a U-2 reconnaissance plane on May 1, 1959, the consequent collapse of the Paris Summit Conference of May 16, and other difficulties with Cuba. This forced another reorganization within LAD, and, under Colonel Thomas J. Hayes III, in October 1959, the Los Angeles Field Office for Military Construction, OCE, was created to accelerate the construction of ballistic missile and space program facilities for the Air Force.

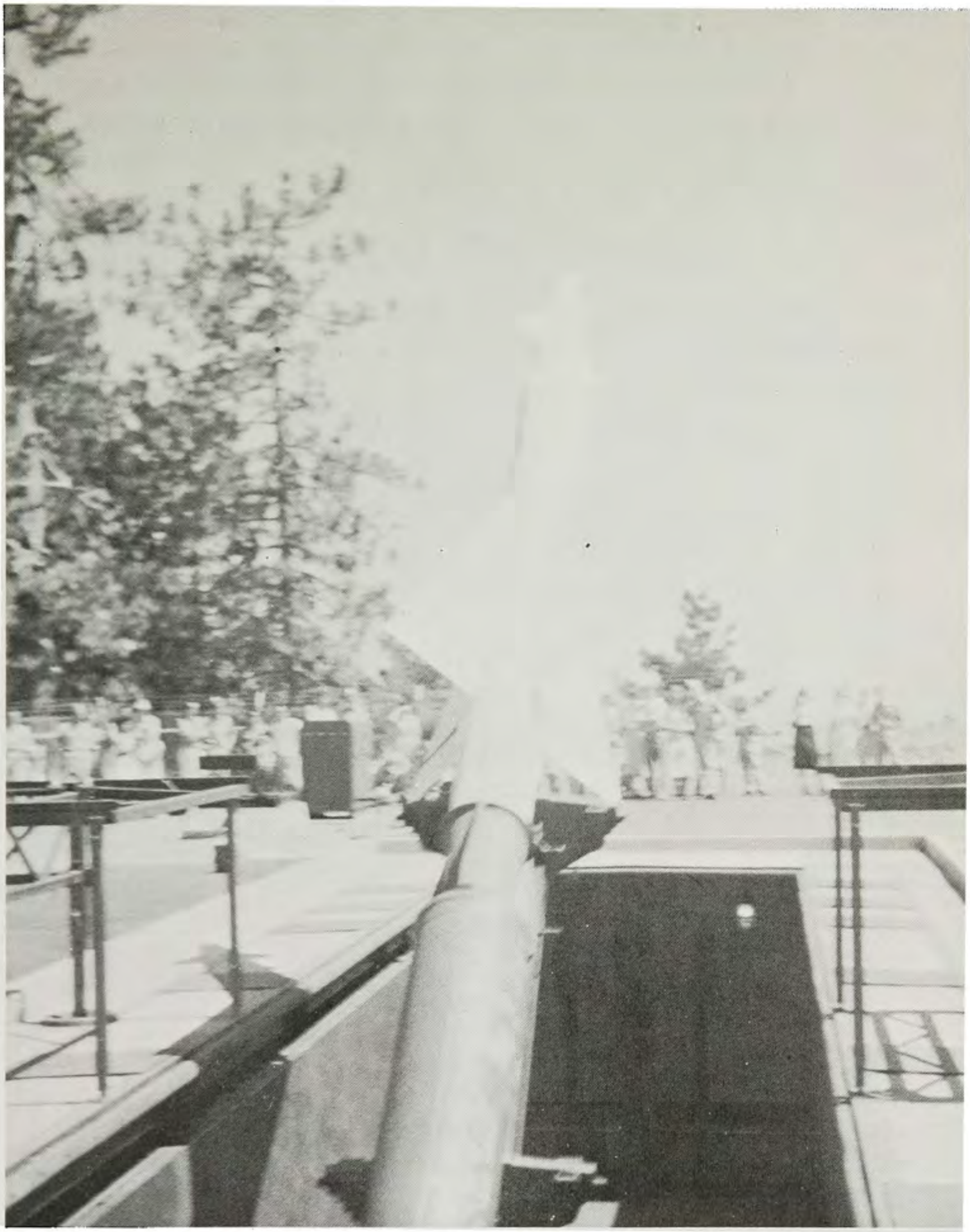
This change did not quiet the charges of a "missile gap," as the program became a major political issue in the Presidential election of 1960. Now the Chief of Engineers established a specialized single agency, with responsibility for overall supervision and coordination of construction for the ICBM program – the Corps of Engineers Ballistic Missile Construction Office (CEBMCO). The South Pacific Division and the Los Angeles District still rendered whatever support CEBMCO deemed necessary.

This opportunity to assist in the defense of the country attracted officers and civilian employees of the Corps of Engineers from all parts of the country. In addition many District employees originally with the project joined CEBMCO. Among the staff from the District were officers like Colonel Hayes, Lieutenant Colonel Clifton H. Chamberlain, and Lieutenant Colonel Allen W. Sanders, and civilian employees like Raymond E. Hole, Abner C. Bjork, Sidney Levenson, Donald W. Sloss, Lester C. Hall, Joseph M. Bridwell, and many others.

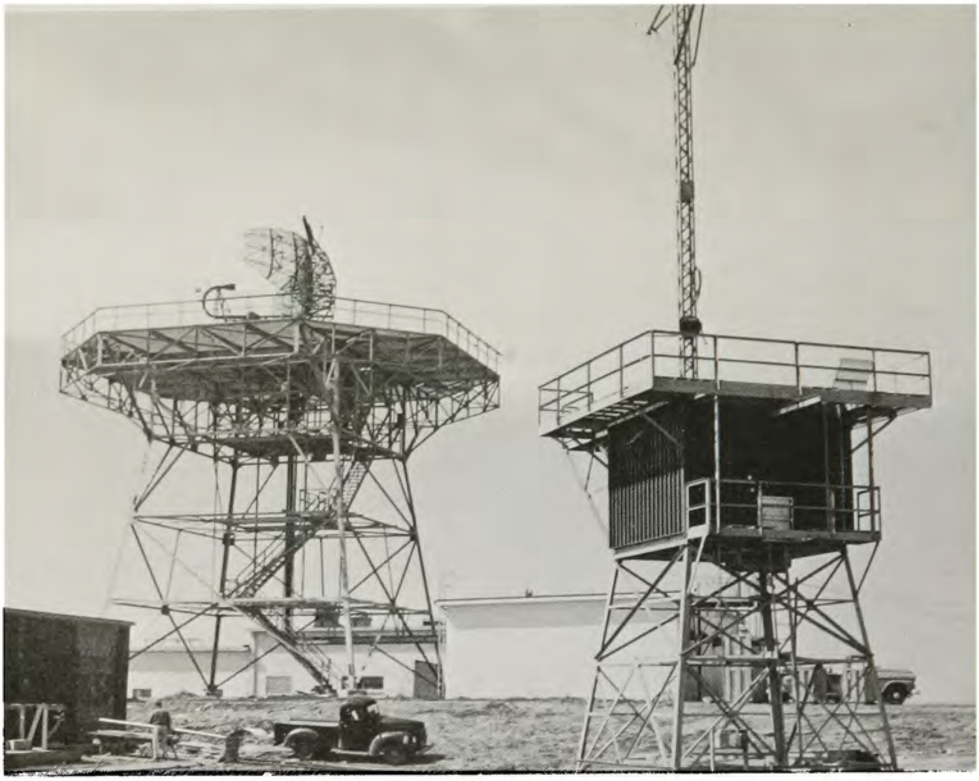
In interviews they recalled the excitement and urgency of the program which often demanded a 6 or 7 day workweek, a workday that from time to time extended far beyond 8 hours, and a loss of family life for long periods of time. Their reward was the completion of the ICBM program with maximum efficiency and at a rate commensurate with the national urgency of this critical program. Their accomplishments were recognized as an outstanding contribution in the long history of Corps of Engineers' achievements.

With the success of the program assured, CEBMCO dissolved, and its staff usually returned to their original districts or divisions. Within the District, besides the work at Vandenberg, construction continued on Titan II facilities at Davis-Monthan AFB, Tucson, Arizona.

In 1965 Colonel John A. B. Dillard, District Engineer, arranged with the Air Force Systems Command Civil Engineer at Vandenberg for the



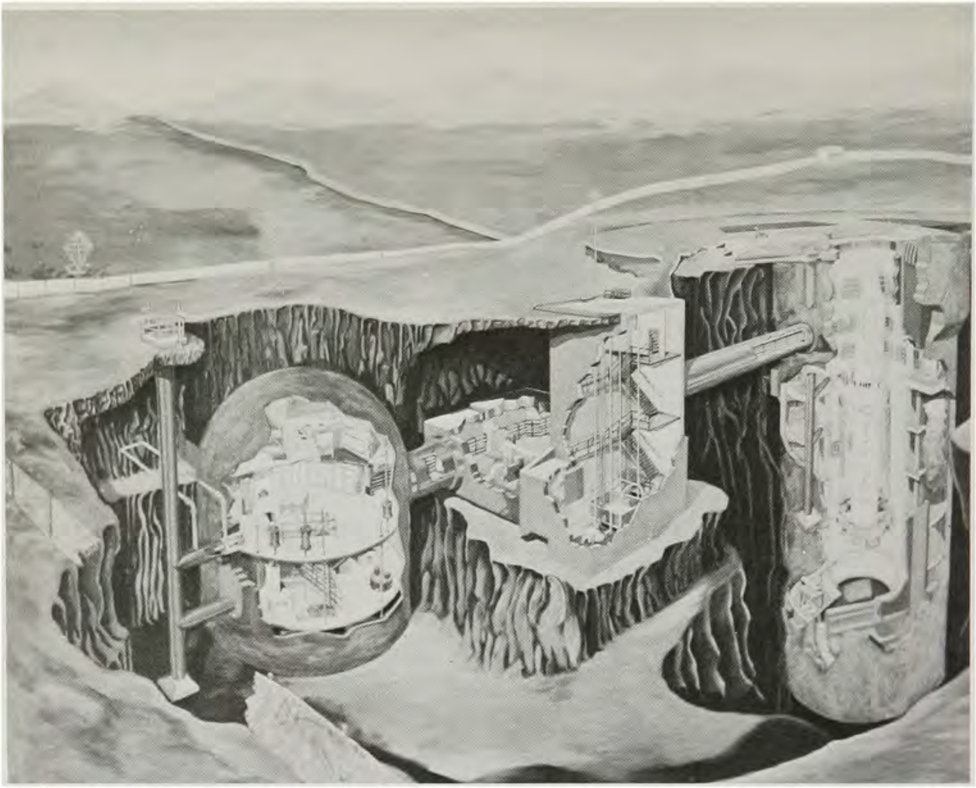
Nike Missile, Edwards Air Force Base, California.



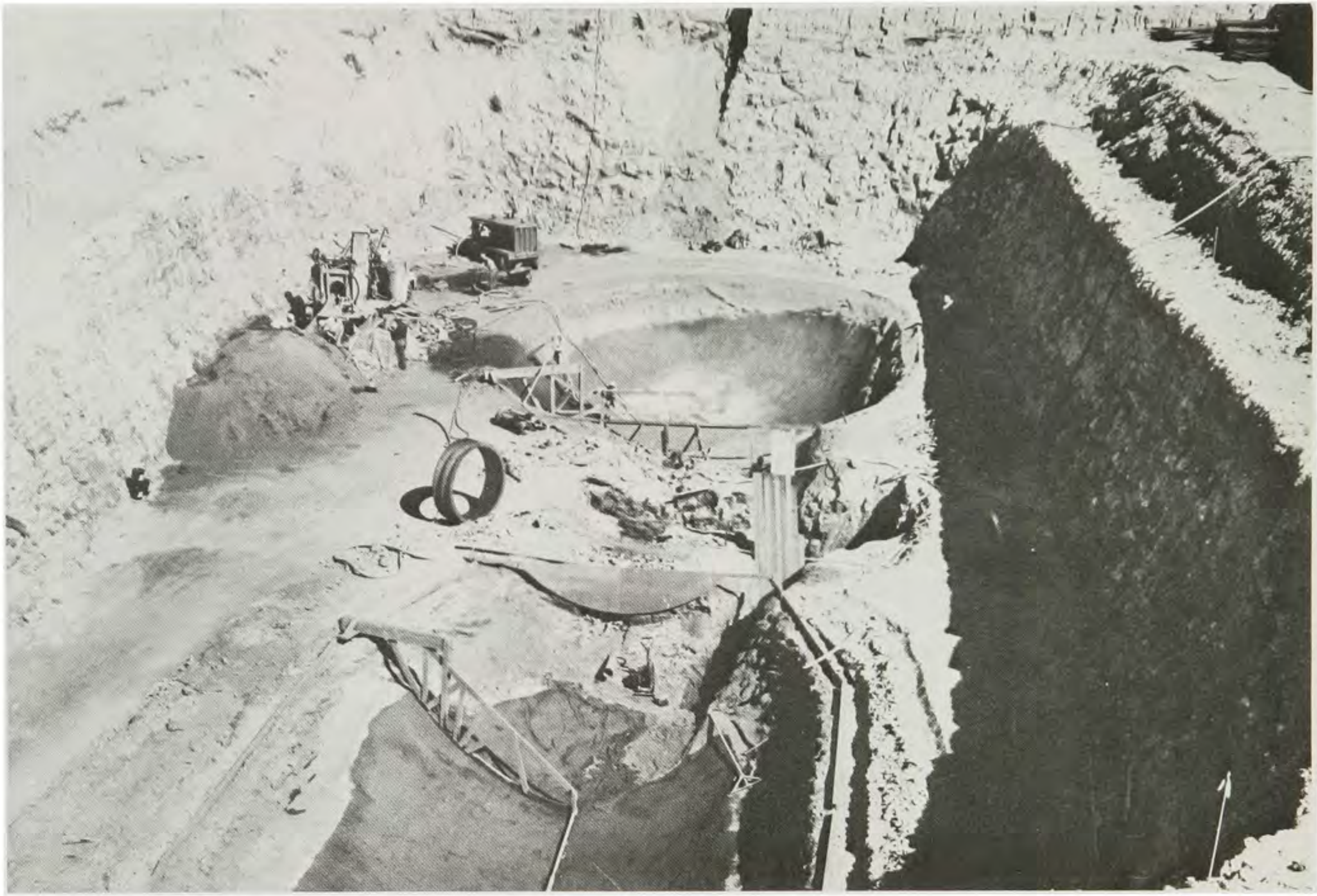
Radar tower, Ft. MacArthur, California (1960).

Corps of Engineers Ballistic Missile Construction Office Exhibit, November 1960.

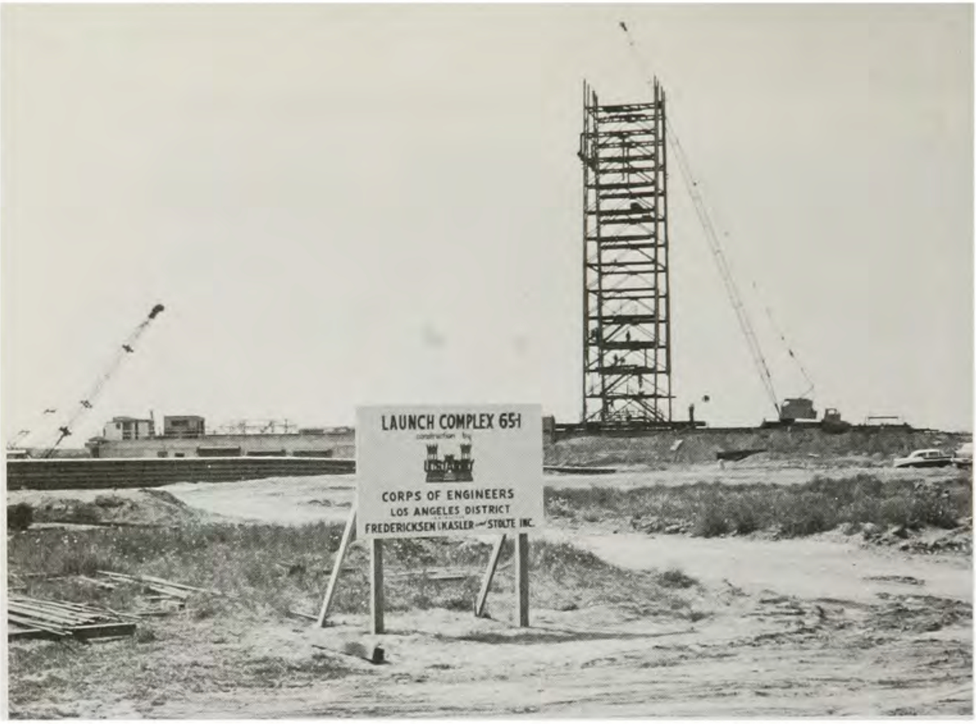
Vandenberg Air Force Base, formerly Camp Cooke.



Titan Complex. An artist's conception of a Titan II launch complex shows the missile in a 155-foot silo, fully fueled and ready to launch. The control center building (left) also contained sleeping and dining facilities. The central portion of the complex contained electrical, diesel, and battery power sources. (U.S. Air Force photo, Vandenberg AFB)



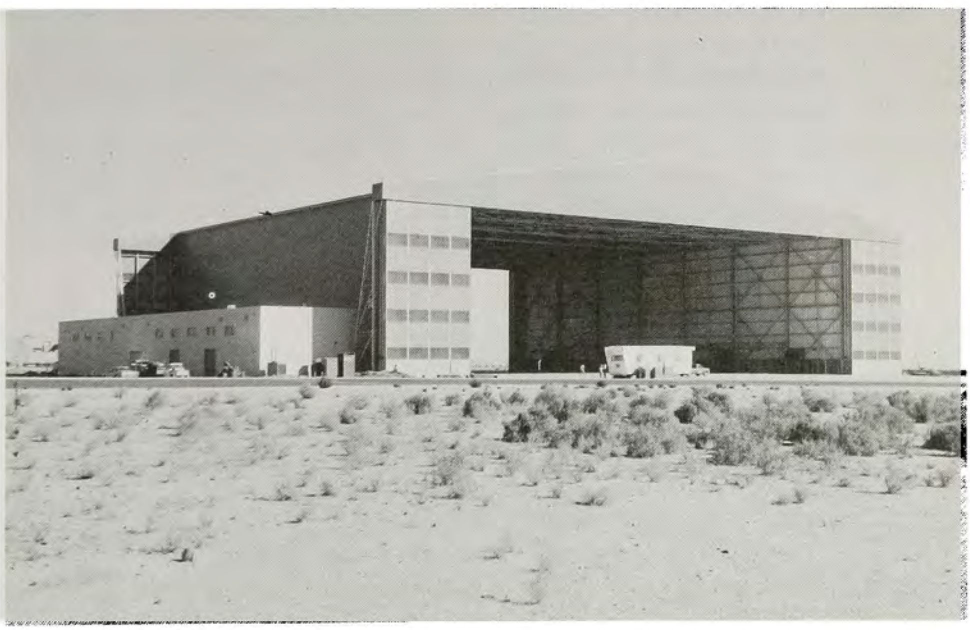
Minuteman Wing VI, Launch Control Center, under construction by Los Angeles District, Vandenberg Air Force Base (1964).



Atlas D. Launcher, Vandenberg Air Force Base (1958).

Saturn Super Rocket Engine Test Stand, Edwards Air Force Base. (U.S. Air Force Photo, 1962)

F-1 firing on Test Stand B, Edwards Air Force Base. (U.S. Air Force Photo)



Hangar for Aircraft Test Facilities, Edwards Air Force Base.

establishment of a Western Area Office, Vandenberg AFB, as the field organization of the Los Angeles District, with both organizations sharing responsibility for facilities construction at Vandenberg for the Titan III standard launch vehicle system, including payload associated facilities.

In other areas of the space program, the Los Angeles District had established what Colonel Norman E. Pehrson, District Engineer (January 1967-September 1969), called excellent "customer relations." He was reiterating the pride that a predecessor, Colonel Earl G. Peacock, had expressed over the fact that the National Aeronautics and Space Administration (NASA) had selected the Corps of Engineers as its partner in marshalling American construction power for the significant and complex task of the exploration of space, a peaceful field of international competition.

For NASA, beginning early in 1959, the District designed and supervised construction of the F-1 Engine Acceptance Test Complex at Edwards AFB for the George C. Marshall Space Flight Center, Huntsville, Alabama (MSFC). The District also designed the S-IVB Test Complex in Sacramento and performed design and construction at the Flight Research Center (Edwards AFB) and at the Western Test Range (Vandenberg AFB) for the Kennedy Space Center.

In monitoring design and construction of these facilities, a new managerial concept was introduced, according to Brigadier General Arthur H. Frye, Jr., Division Engineer, South Pacific Division, who also had been District Engineer, LAD (1953-1957). The project, the F-1 Engine Acceptance Test Complex, demonstrated how this concept worked. A liaison team of engineers was composed of one member of the MSFC, one member from the ultimate user of the stand (Rocketdyne), one member from the architect-engineer firm (Ralph M. Parsons Company), and one member from the Corps of Engineers. The functioning of this team, supported by their home offices, provided quick approval of the design as it progressed and of construction.

The design of the test complex was directed by LAD and performed by the Ralph M. Parsons Company and Rocketdyne. The test facility included three test stands, a control building, instrumentation tunnels, electrical support buildings, pre-test buildings, observation bunkers, and superstructures for each of the stands and on-stand and off-stand propellent systems. Within the control building and on the stands, complete instrumentation systems were built. LAD also designed an access road for the whole area. To provide sufficient water for use in the acceptance testing of the F-1 Engine, the District designed a special water system.

With this ideal research center, MSFC produced the F-1 Engine which, with its 1.5 million pound thrust, provided the power for the first-stage launch of vehicles used in manned moon exploration and deep space probes. With quiet satisfaction the District staff listened to the famed space scientist, Dr. Werner Von Braun, extol their cooperation with architect-engineers, construction contractors, and the Air Force in producing the testing facility which removed another "significant obstacle from man's path to the moon and outer space."

LAD also performed other activities for NASA. In addition to many small items, the Flight Research Center, Edwards AFB, requested the District, in June 1963, to develop criteria, prepare plans and specifications, and arrange for construction of a High Temperature Loads Calibration facility, with connecting taxiway and runway. The Jet Propulsion Laboratory, Pasadena, California, assigned such projects to the District as building a material service building, a low energy laboratory, and relocating of prefab buildings.

In the spring of 1964 the Kennedy Space Center, Unmanned Launch Operations, Lompoc, California, one of the smaller installations of NASA, assigned to the District the responsibility for design and construction of several minor projects, including an operations support building, Scout Systems checkout facility, isotope storage building, and a tracking antenna pad. In addition, the District prepared in 1965 preliminary engineering reports for a Delta Service tower and for clean room facilities.

By the late 1960's the military construction program of LAD declined, as Army and Air Force installations were almost saturated with the necessary facilities, and the various missions of NASA were completed. In the light of past experience, Colonel Pehrson confidently predicted that the military construction program of the District would again become prominent among the activities of LAD.

The Los Angeles District was active not only in military defense, but also in civil defense. In October 1961, LAD was assigned the responsibility to conduct a fallout shelter survey, with the objective of examining all structures for possible use in civil defense. The survey was divided into two phases, with phase one performed by contract. During phase one all structures capable of sheltering 50 people with a protection factor of at least 20 (20 times safer than outside) were identified. During phase two an evaluation of the suitable shelters was made to determine what modifications were necessary to increase their capacity and improve the protection factor from 20 to 100 (100 times safer than outside).

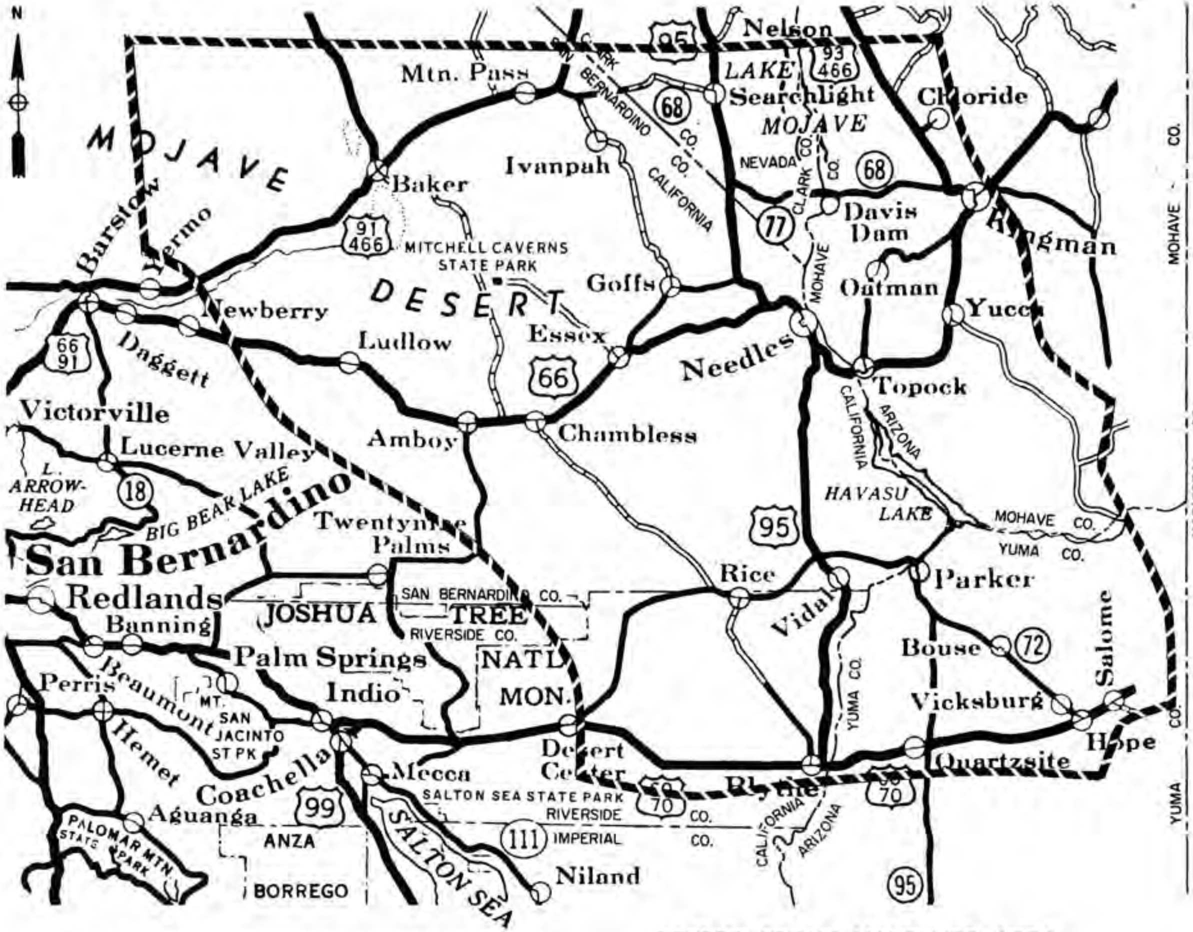
At the request of the Air Force, the Los Angeles District executed the challenging mission of constructing the largest experimental seismic observatory, which had both military and civilian benefits. When turned over to the Air Force on 19 March 1963, the facility (Tonto Forest Seismological Observatory, Payson, Arizona) had sophisticated seismological equipment available for research on seismic waves from underground nuclear explosions and earthquakes, and for devising methods which could distinguish between man-made signals and natural ones.

In 1964 the Los Angeles District received an unusual assignment: the preparation of a military maneuver area almost three times the size of New Jersey, approximately 13 million acres of land. The Department of Defense required this area to hold exercise Desert Strike to test the combat capabilities of the U.S. Army in any possible emergency. Over 100,000 American soldiers from all over the country would participate in one of the largest peacetime maneuvers in the history of this country.

To clear the area for use, Colonel Peacock and his Real Estate Division pulled off a fantastic real estate operation. The maneuver area was located on both sides of the Colorado River within the States of Arizona, California and Nevada. Within the region there were approximately 5,000 ownerships over which permits for use by military forces were secured. Generally, permits were not obtained in urban areas, or from roadside business establishments, 1/2 to 5 acre homesites, irrigated farmlands, operating mines, and public service sites. They were delineated on maps and declared "OFF LIMITS" to troops. To protect the environment, travel was restricted through stands of cholla cacti and Joshua trees and wildlife refuges to existing roads.

Conferences were held with railroads, utility companies, water districts, and State and county highway departments, conferences which determined the means of protecting their facilities from possible damage. Information on safe crossings through their facilities was obtained. Contracts for the use of rail facilities and the purchase of fresh water for the maneuver troops were made.

Since a considerable proportion of the maneuver area was committed to cattle grazing, special briefings were held to assure ranchers that damage to their cattle and improvements would be kept to a minimum. In fact, all property owners were assured that the troops would repair damages resulting from the exercise. To adjudicate expeditiously all claims to any unrepaired damage, the District scattered claims offices throughout the area. In 1965 LAD had made complete settlements of 56 claims for damages to land and improvements for a total payment of $333,793. Tentative agreement on another 20, totaling $41,828 had been reached, leaving four claims still to be negotiated.



"REPRODUCED BY PERMISSION OF THE COPYRIGHT OWNER, AUTOMOBILE CLUB OF SOUTHERN CALIFORNIA"

DESERT STRIKE MANEUVER AREA
CALIFORNIA - ARIZONA - NEVADA

For its role in this mission LAD was awarded a Certificate of Appreciation, which declared: "The achievements of the United States Army Engineer District, Los Angeles, California, were a significant contribution to the success of a mission of great importance to the National Defense program and brought distinction upon the organization, the United States Army, and the United States Strike Command."

This brief survey of the military work of the Los Angeles District clearly reveals a highly competent organization under capable leadership which has been responsive to the challenges of the changing conditions and requirements of the international crises of the past 70 years.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

In 1965 the personnel of the Los Angeles District, Army Corps of Engineers, past, present, and future, could look back at a distinguished record of service, free from corruption and noted for correcting the environmental weaknesses of a most desirable geographic area to live in. Not only did LAD undertake what the people of the District desired, but it also rejected requests when costs exceeded the benefits.

With its record of achievement LAD had kept pace with the increasing demands of the public and of national defense. Colonel John A. B. Dillard, District Engineer, reported that between 1898, the date of the formal establishment of the Los Angeles District, and June 30, 1965, in southern California alone LAD expended $509 million for civil works construction and $1.19 billion for military construction. Before this work started, a great deal of imaginative planning was required. Through this dynamic planning approach, practiced since the inception of the Corps, LAD completed studies or was making studies blanketing nearly all of the District. This, in turn, not only furnished Congress with the information necessary to authorize many feasible improvements, but also established a comprehensive body of authoritative knowledge about water resources and related problems. The activities of LAD in carrying out congressionally assigned responsibilities had a direct influence on the lives of the people within the boundaries of the District, especially in assisting these people to meet the challenge of population growth, the need for economic expansion, and the development of suitable living patterns. Within the arid lands which comprise the District, great metropolitan regions bloomed, in part the result of man-made developments like harbors and water resource projects. Through its work LAD touches the lives of everyone within its geographic limits.

The personnel and office facilities of LAD have expanded and contracted as military and civil works requirements dictated. Captain James J. Meyler and his staff of 18, operating out of the old Central Building in downtown Los Angeles, proved sufficient for their first task, the construction of the harbor at San Pedro. Several years later the small but competent staff transferred to one large room in the Eighth and Figueroa Building. Even World War I did not call for any major increase in personnel. During that war, LAD concentrated on the major expansion of fortifications at Forts Rosecrans and Mac Arthur by emplacement of seacoast artillery as a deterrent against possible enemy

action. Motorized equipment, which was used extensively on those projects, heralded the end of mule and horse power. Engineer officers proved the value of their tours of duty with LAD by their engineering successes in France during World War I.

Up to 1934 expansion was gradual, since LAD's primary concern was limited to navigational responsibilities. Since that time flood control work, military construction responsibilities during World War II, the Korean War, and the Cold War, and the increasing emphasis on the ballistic missile program forced the organization to mushroom. By 1958 the District had 1,350 employees and occupied nearly five floors of the Eighth and Figueroa Building. Included in the staff were area engineers and project engineers who supervised about 125 military construction contracts and 15 civil flood control contracts in seven western states. By creating a well-balanced organization, the District Engineers accomplished a huge volume of work in record time. From 1948 to 1958 the military construction workload of LAD averaged from $50 to $100 million per year. After that date, a steady decline in workload and staff developed. In 1961 the District, with a $92 million workload, had a staff of 1,128. By fiscal year 1965 the workload declined to approximately $82 million with a manpower strength of 876.

In June 1965 the District moved into the new Los Angeles Federal Building where they occupied 77,645 square feet on the 6th floor, 16,524 square feet on the 7th floor, and 8,309 square feet in the basement. This move greatly improved working conditions and the physical environment.

There was an ominous prospect confronting LAD: the possibility of retirement of key personnel. A considerable number of those who joined in the 1930's and 1940's were eligible for retirement in the 1960's. Many represented the backbone of the organization, and their loss might have a deleterious impact on the District mission. Fortunately, LAD had enough younger men in responsible positions to mitigate the shock. As the latter advanced, there still remained the problem of replacing them with younger persons. Those District personnel facing retirement would leave with the satisfaction of a record of engineering performance difficult to match by other districts, primarily because of a larger and more varied engineering workload. Moreover, their satisfaction would prove invaluable in the resolution of the recruitment problem.

Within southern California alone the Los Angeles District had either completed or had under construction in 1965 numerous projects, including 13 dams, more than 350 miles of channel improvement, 11 harbors, and 11 beach-erosion-control projects.

Flood control works had already prevented almost $300 million of damage, and completion of all flood control projects in southern California would prevent more than $1 billion of damage if and when a major flood occurred. (Such a flood occurred the winter of 1969-70. The savings from this single major storm matched the expenditure of almost $1 billion for the flood control program.)

As of January 1, 1966, 99 percent of the facilities proposed under the comprehensive plan for the Los Angeles County Flood Control District were executed with completion scheduled for 1967. Thus the metropolitan region of Los Angeles, which was once under a more dangerous flood menace than any similar metropolitan area in the United States, was relatively free from the dangers of a major flood. In addition, other benefits accrued. Areas previously subject to inundation, bank erosion, and stream diversion became highly developed residential and industrial regions. Some of the runoff from the watersheds, instead of rushing to the sea, was retained behind flood control dams, diverted to conservation and spreading basins, and percolated into the ground for recharging the water table. The open space of reservoir lands was converted into recreational areas by local and State agencies. The regional economy benefitted from the millions of manhours of work provided by the program. The protection of industrial areas from floods turned into a major asset for military defense when industry converted to the production of war materials during World War II, the Korean War, and the Cold War.

In the Santa Ana River Basin, LAD matched the success of flood control work in the Los Angeles County Drainage Area. Because of rapidly expanding urban developments, further extensive flood control works will be necessary for the Upper Santa Clara River Basin, Santa Ana River Basin, Santa Barbara County streams, Mojave River drainage area, and San Diego County.

Similarly, in Arizona flood control programs are necessary to meet the urgent needs of the urban, suburban, and agricultural areas of the State. Of the 15 projects authorized only five had been finished by 1965. After this date, LAD still had to execute comprehensive planning and construction to check the recurrent floods which not only caused damage and destruction but also wasted into the Gulf of California vast amounts of precious water which could be of considerable benefit to the people, agriculture, and industry in Arizona.

Within Nevada, the Las Vegas, Clark County, area requires flood control improvements, but local initiative is necessary before LAD may act.

A comprehensive framework study by a State-Federal interagency group, including LAD, has been authorized for the lower Colorado River Region, with planning to begin in 1967.

In 1965 LAD still had an extensive flood control program with nine flood-control projects authorized for construction, 25 investigations completed or in progress, nine authorized studies not funded, and on file investigations requested by local interests. When these programs are implemented, damages of hundreds of millions of dollars will be prevented during major floods. Multipurpose planning also will create optimum utilization of water and land resources within the area of LAD.

To reduce unnecessary expenditures of limited funds for increasingly expensive flood control projects and to minimize possible flood damage by preventing encroachment of urban and suburban developments on flood plains, Congress in 1960 authorized the Corps to make flood plain information studies at the request of local and State governments. At the request of the State of California a statewide flood plain information study program was initiated in 1966 to include 73 study areas, of which 19 were in southern California. Previously authorized studies were incorporated into the long-range program. In addition, LAD has completed or has underway flood plain information studies in Maricopa County, Arizona, and in Clark County, Nevada. This particular aspect of water resource development will assume a steadily increasing significance for the Los Angeles District. Hopefully LAD will impart wisdom to people who are prone to ignore the environmental dangers of settling on flood plains.

One byproduct of flood control work, not foreseen in the earlier stages of its development, was recreation. By 1965 the recreational mission of the Los Angeles District had assumed far greater importance than anyone had realized. District officials pointed out that the overall significance of reservoir lands to recreational development was overlooked too often in the past. Mushrooming under the impact of a population explosion, urban development gobbled up such huge amounts of land that it was soon apparent that reservoir lands were perhaps the only large open areas left in metropolitan regions. Developers and local officials urged numerous plans for commercial or other uses of these invaluable lands, but District officials steadily resisted such pressures for nonrecreational use of reservoir lands. To reduce this pressure and to further recreational development, District officials stimulated the licensees (local and State agencies), by personal contacts, by clarifying, strengthening, and enforcing the terms of the licenses, and by obtaining excellent communications media coverage of the recreational mission, to cover the open reservoir lands with recreational facilities.

These efforts not only produced major results, but also justified a continuing strong interest by the District in public recreation. An increase of over 1 million visits in 1 year, 1964 over 1963, at five main reservoirs in the metropolitan region of Los Angeles alone indicated a "recreation explosion." Future prospects for further recreational development on reservoir lands were enhanced as Congress authorized, in 1965, the Army Corps of Engineers to incorporate the construction of recreational facilities into projects and then enter into agreements for local and State agencies to manage these facilities. This arrangement obviates the problem of smaller governmental institutions' lack of funds. The landmark project was the Alamo Dam complex, which called for Corps-built recreational facilities.

In the areas of pollution control, maintenance of water quality, and protection of the environment, the Corps of Engineers, including LAD, continues to face all kinds of questions and emotions. The answers evolved will have a profound impact on resource development. Upon the engineers, society will place the major burden for both the preservation of the environment and the development of its resources so that Americans may continue to have affluence coupled with a high quality of life. Up to 1965 LAD had fulfilled the objectives of the people within its area and it could be expected to improve milieu which distinguished the way of life of these people from the rest of the population in the United States.

When LAD first began studies, around 1934, of the erosion of beaches and cliffs along the shoreline of southern California, the problem of erosion was not considered a serious one. The flood control system, while providing protection from flood damage, also reduced the natural replenishment of beaches and accelerated erosion. In addition, each man-made structure that projects from the shore or is built offshore has an undetermined effect on littoral drift, generally an erosive one.

By preservation and replenishment of beaches, LAD assists in meeting the population's need for recreational facilities. Beach erosion projects completed or under construction by 1965 protect more than 35 miles of beach with more than 20 million users annually. In October 1965 LAD also had two beach erosion projects authorized, but not yet started, 11 investigations underway, and two authorized investigations not funded. In order to arrive at better solutions, the Corps instituted a research program to strengthen engineering knowledge in shore protection.

Nothing better illustrates the ability of LAD to cope with the challenge of the changing needs posed by rapidly growing areas within the District than the development and maintenance of major harbors at Los Angeles and Long Beach and at San Diego. Although the San Diego

Harbor is one of the finest natural harbors in the world, its location prevented its proper utilization by southern Californians. Properly to service these people, artificial harbors were built at San Pedro and Long Beach, mainly by the engineers of the Los Angeles District. In fact these developments gave birth to the Los Angeles District. Out of mudflats emerged one of the most extensive man-made harbor areas in the world. A breakwater 6.1 miles in length, constructed by LAD, protects the water-land port complex of Los Angeles-Long Beach. To date, Federal costs have been $33 million, with local costs of $365 million, all of which provided a considerable boost to the economy. Booming business and annually increasing tonnage offer strong evidence of the success of this harbor complex. But technological innovation in ocean-borne cargo demand continuous modernization. Containerization-handling facilities and new terminals for supertankers and huge special purpose vessels must be provided not only for the Los Angeles-Long Beach Harbor but also for the San Diego Harbor. Proposed improvements by interested parties include deepening channels to handle vessels with drafts of 60 feet.

In addition to the development and maintenance of major harbors the Los Angeles District had its navigational responsibility expanded by the demand for small craft facilities, a demand created by rapidly increasing numbers of small boat enthusiasts. The ultimate objective for all governmental institutions concerned with this need is to provide the boating public with recreational opportunity and with safety by constructing harbors in relative proximity so that small craft will always be reasonably near to a harbor of refuge. When all plans for such harbor projects reach fruition, facilities to serve 35,000 small craft will be available. Through the cooperation of local, State, and Federal interests some of the finest marinas in the world – in particular Marina del Rey, Redondo Beach King Harbor, and Newport Bay Harbor – already exist. Nevertheless, James W. Chapman, Navigation Section, LAD, has warned that, while berthing facilities will reach a total of 32,000 berths by 1980, the actual need then will be for 47,000 berths.

In 1962 the President's Water Resources Council prepared guidelines to establish a uniform approach to water resources development by all agencies, with the planning objective "to provide the best use, or combination of uses, of water and related land resources to meet all foreseeable short- and long-term needs." The Corps could look back at its own historical role in developing sound water resources programs to see one source of these views. The statement delineated the responsibilities of the Corps to develop multipurpose projects, including municipal and industrial water supply, electric power, major drainage,

pollution control, water quality, fish and wildlife conservation, and other related benefits. From 1962 on, the emphasis was on regional planning, whereby the broad regional interests of a state, or several states, or even different nations had to be considered. LAD is participating in framework planning for the State of California, the upper and lower Colorado Regions, and the International Boundary and Water Commission of the United States and Mexico.

As Colonel Earl G. Peacock, D.E., stated on 6 May 1964: "New techniques are being developed and new disciplines are being employed in the design of water-resource systems. The old conventional economic approach to project justification is being modified to consider the socio-economic aspects of proposed new systems. Economic base studies for large areas are supplanting economic evaluations of only the project area. Computer programs for optimizing resource utilization are being developed and used in allocating water to the several purposes of multipurpose projects." This changing technology or methodology of designing water-resource systems mounted a challenge to the imaginative and creative impulses of all engineers.

In executing its military mission, LAD matches its civil works success. The District contracted for the construction of an amazing variety of structures: reserve training centers, target intelligence training buildings, quarters, service clubs, dormitories, dining halls, armament and electronics shops, Capehart housing, technical buildings, electrical distribution systems, sewage treatment plants, washracks, hangars, airfields, taxiways, jet test cells, squadron headquarters, storm drainage systems, roads, water wells, utilities, and innumerable other structures.

In Arizona the District built important military projects at Davis-Monthan and Luke Air Force Bases, and at Fort Huachuca. In California the major projects were Edwards, George, and Norton Air Force Bases. Additionally, LAD participated in the space age, particularly by transforming Cooke Air Force Base into the Western Test Range, Vandenberg AFB, as a major support for launching missiles, as well as contributing to the development of the missile defense structure of the United States.

Having constructed nearly all possible facilities for the many AF Bases within LAD, having responded efficiently to the exigent missile requirements of CEBMCO, and having topped out the significant LACDA project, with which the District had been involved since 1934, LAD appeared to face a bleak future after 1965. In actuality this prognostication failed to take into account the needs of the huge population centers within the District, in the areas of water resources, major and minor harbors, and the quality of the environment. Major

changes in the military and civil works missions of the Corps also could be anticipated.

After 1965 LAD, as well as all other components of the Corps, would be called upon to utilize engineering knowledge and technology to improve the quality of life by preserving environmental relationships. Even its severest critics recognized that the Corps remains one of the best instruments for achieving that vital objective, for the Corps is the servant not the master of the people. In coping with natural and man-made disasters, the Corps is the best available instrument for emergency work. Through the process of public hearings and other means of communication, the Corps would learn its future role in meeting the social and military responsibilities of society. For LAD continuing cooperation with its public would lead to the preservation and enhancement of a unique way of life, one highly dependent on optimum development of water resources in the region.

APPENDIX

1. U.S. ARMY ENGINEER DISTRICT, LOS ANGELES

A complete list of the officers who served as District Engineers in the Los Angeles District is given below.

Name of Officer	From	To
Captain J. J. Meyler	31 Dec. 1898	12 Dec. 1901
Lt. Col. Chas. E. L. B. Davis	13 Dec. 1901	28 Jan. 1902
Lt. Col. Thos. H. Handbury	28 Jan. 1902	31 Mar. 1902
Captain Edgar Jadwin	31 Mar. 1902	17 June 1903
Major J. H. Willard	17 June 1903	30 Nov. 1903
Captain C. H. McKinstry	30 Nov. 1903	31 Aug. 1905
Colonel W. H. Heuer	30 Aug. 1905	16 Oct. 1905
Major C. H. McKinstry	16 Oct. 1905	10 Feb. 1906
Captain Amos A. Fries	10 Feb. 1906	10 Aug. 1909
Lt. Chas. T. Leeds	10 Aug. 1909	2 Aug. 1910
Captain W. P. Stockey	2 Aug. 1910	30 Nov. 1910
Captain Chas. T. Leeds	30 Nov. 1910	8 Dec. 1911
Captain W. P. Stokey	8 Dec. 1911	6 Jan. 1912
Lt. Col. C. H. McKinstry	6 Jan. 1912	31 Dec. 1913
Major R. R. Raymond	31 Dec. 1913	31 Jan. 1916
Major G. B. Pillsbury	31 Jan. 1916	30 Apr. 1917
Major Chas. T. Leeds	30 Apr. 1917	1 July 1919
Major Frederick B. Downing	1 July 1919	9 Sept. 1920
Major C. Carlington	9 Sept. 1920	7 Dec. 1920
Major Frederick B. Downing	7 Dec. 1920	25 July 1921
Major E. D. Ardery	25 July 1921	25 June 1924
Major H. A. Finch	25 June 1924	1 July 1927
Major C. P. Gross	1 July 1927	19 July 1929
Lt. A. B. Shattuck	19 July 1929	3 Oct. 1929
Major W. H. Lanagen	3 Oct. 1929	13 July 1933
Colonel V. L. Peterson	13 July 1933	15 Feb. 1934
Major H. H. Stickney	16 Feb. 1934	20 July 1935
Major Theodore Wyman, Jr.	20 July 1935	31 Aug. 1939
Lt. Col. Edwin C. Kelton	1 Sept. 1939	25 June 1941
Colonel Edwin C. Kelton	26 June 1941	19 July 1942
Colonel Rufus W. Putnam	20 July 1942	1 Feb. 1946
Colonel Robert C. Hunter	1 Feb. 1946	26 Dec. 1946
Colonel Joseph O. Killian	27 Dec. 1946	13 Feb. 1947

Colonel A. T. W. Moore	13 Feb. 1947	30 Apr. 1949
Colonel W. D. Luplow	1 May 1949	1 Nov. 1950
Lt. Col. W. R. Shuler	21 Nov. 1950	30 June 1953
Colonel Arthur H. Frye	13 July 1953	11 July 1957
Colonel Carrol T. Newton	22 July 1957	12 Aug. 1960
Colonel William T. Bradley	12 Aug. 1960	11 Jan. 1963
Colonel Earl G. Peacock	12 Jan. 1963	30 Apr. 1965
Colonel John A. B. Dillard	25 June 1965	27 Dec. 1966
Colonel Norman E. Pehrson	9 Jan. 1967	30 Sept 1969
Colonel Robert J. Malley	1 Oct. 1969	1 Aug. 1971
Colonel Harry M. Roper	1 Aug. 1971	10 July 1973
Colonel John V. Foley	10 July 1973	

2. Major Charles T. Leeds and Staff, June 1, 1917.

3. LOS ANGELES DISTRICT OFFICE AND FIELD SUPERVISORS c. 1936.

Under Major Theodore Wyman, D.E., LAD, 15 July 1935 – 31 August 1939 an important reorganization of the District took place which influenced the mission of the District for the next 35 years.

District Engineer	Theodore Wyman, Jr., Major, CE	
Executive Officer	R. E. Cruse, Captain, CE	
Executive Officer	C. R. Jones, 1st Lieut., CE	
Executive Officer	N. A. Matthias, Captain, CE	
Military Assistant	R. E. Cruse, Captain, CE	
Military Assistant	H. Milwit, 1st Lieut., CE	
Military Assistant	G. K. Withers, Captain, CE	
Military Assistant	N. A. Matthias, Captain, CE	
Operations Officer	Morris W. Gilland, Captain, CE	
Operations Officer	Louis J. Claterbos, Captain, CE	
Operations Officer	G. K. Withers, Captain, CE	
Chief, Engineering Division	R. E. Cruse, Captain, CE	(1936)
Asst. Chief, Engineering Division	Mr. G. B. Archibald	(1936)
Chief, General Engineering Division	Mr. Guy B. Bebout	(1935)
Asst. Chief, Engineering Division	Mr. F. G. Christian	(1935)
Head, Structural Design Subdivision	Mr. L. T. Evans	
Head, Hydraulic Design Subdivision	Mr. J. G. Jobes	
Head, Specifications Subdivision	Mr. J. E. Hallock	
Head, Right-of-Way Subdivision	Mr. F. D. Wilcox	
Group Leader, Planning	Mr. C. R. Snow	
Group Leader, Planning	Mr. D. W. Morrison	
Group Leader, Planning	Mr. M. Parsons	
Group Leader, Planning	Mr. O. A. Arnold	
Group Leader, Planning	Mr. H. W. Thompson	
Head, Survey & Drafting Subdivision	Mr. E. R. McChesney	
Area Engineer	G. K. Withers, Captain, CE	
Area Engineer	H. Milwit, 1st Lieut., CE	
Area Engineer	Mr. K. J. Harrison	
Area Engineer	Mr. F. C. Bennett	

Job Engineer	Mr. Paul A. Hack
Job Engineer	Mr. John F. Heinmiller
Job Engineer	Mr. F. Gunner Gramatky
Job Engineer	Mr. Louis G. Frick
Chief, Inspection Division	Mr. Harry Hodgman
Assoc. Supt.	Mr. O. H. Ochsner

For December 1937 add the following:

Area Engineer	Thomas H. Holmes
Job Engineer	Stewart Bate
Job Engineer	Frank N. Huddleston
Group Leader	L. R. Young

For 1938 add:

Asst. Chief, Operations Division	Mr. W. G. Leen
Job Engineer	Mr. J. N. Hendrickson
Job Engineer	Mr. Paul A. Hack

4. KEY PERSONNEL IN LAD OFFICE AND FIELD, 1939:

District Engineer	Theodore Wyman, Jr., Major, CE (7/15/35-8/31/39)
District Engineer	Edwin C. Kelton, Lt. Col., CE (9/1/39-7/19/42)
Executive Assistant	N. A. Matthias, Capt., CE
Executive Assistant	L. Rosenberg, Capt., CE
Executive Assistant	A. A. G. Kirchhoff, Capt., CE
Executive Assistant	G. K. Withers, Capt., CE
Military Assistant	L. Rosenberg, Capt., CE
Military Assistant	A. A. G. Kirchhoff, Capt., CE
Military Assistant	H. Milwit, 1st Lieut., CE
Chief, Operations Division	L. Rosenberg, Capt., CE
Chief, Operations Division	G. K. Withers, Capt., CE
Asst. Chief, Operations Division	H. Milwit, 1st Lieut., CE
Chief, Engineering Division	Ralph Cruse, Capt., CE
Chief, Engineering Division	N. A. Matthias, Capt., CE
Asst. Chief, Engineering Division	Mr. G. B. Archibald
Asst. Chief, Engineering Division	Mr. F. C. Christian
Chief, Rights-of-Way Subdivision	A. A. G. Kirchhoff, Capt., CE
Chief, Rights-of-Way Subdivision	Mr. Harry Hodgman
Chief, Rights-of-Way Subdivision	Mr. W. E. Whittier
Chief, Rights-of-Way Subdivision	Mr. H. E. Spickard
Chief, Inspection Division	Mr. Harry Hodgman
Head, General Engineering Section	Mr. H. W. Thompson
Head, Hydraulics Section	Mr. J. G. Jobes
Head, Channel Design Section	Mr. L. T. Evans
Head, Laboratory Section	Mr. L. W. Miller
Head, Specifications Section	Mr. J. E. Hallock
Head, Survey & Drafting	Mr. R. Altman
Area Engineer - 1st Area	Mr. George J. F. Carey
Area Engineer - 2nd Area	Mr. F. C. Bennett

Area Engineer - 3rd Area	Mr. K. J. Harrison
Job Engineer	H. R. Hallock, Lieut.
Job Engineer	Mr. Frank N. Huddleson
Job Engineer	Mr. James G. Morgan
Job Engineer	Mr. Otto C. Hartman
Job Engineer	Mr. Paul A. Hack
Job Engineer	Mr. Leonard G. Hogue
Job Engineer	Mr. E. B. Fontaine

5. Engineering Division, LAD, 1936.

6. Some of the Personnel, LAD, 1939.

First Row
D. Phillips
H. Hodgman
E. Heritage
G.McMillen
W.J. Leen
E. Tunison
S.T. Johnson
E.S. McCandless
P. B. Gair
H. E. Spickard

Second Row
C. Hammond
F. Meinecke
H. Brewer
E. Tandberg
E. Campbell
F. Webster
L. Rose
D. Usrey
C. Preyer
H. Zeh
H. Cox

Second Row
C. Hollcraft
R. LaMori

Third Row
W. Tadlock
C. Perrine
H. B. Watkins
A. G. Mickow
A. Mangelsen
L. Stover
C. E. Mendenhall

Third Row
W. Damewood
P. Beardslee
K. Tonkin
W. McBrien
C. Neely
A. Wilson
D. Ball

Fourth Row
W. Mayfield
D. Armstrong

Fourth Row
J. Gordon
A. Higgs
L. Gibbons
J. J. Hurd
C. Chase
Luke Watson
C. J. Caward
W. McComber
F. Schaab
- - - - -
G. Swab

7. Organizational Chart, LAD, August 25, 1943.

LOS ANGELES, CALIFORNIA DISTRICT
751 So. Figueroa Street
DISTRICT ENGINEER
COLONEL RUFUS W. PUTNAM

EXECUTIVE OFFICER
Lt. Col. H. F. Thompson, C.E.

CONTROL OFFICER
Major E. B. Bailey, C.E.

ADMINISTRATIVE DIV.
Maj. Milburne Webb, C.E.

MILITARY ENGRG. DIV.
Lt. Col. W. J. Leen, C.E.

CIVIL ENGRG. DIV.
Guy B. Bebout

SERVICE DIVISION
Lt. Col. Henry Crown, C.E.

YUMA AREA
Yuma, Ariz.
Capt. R. A. Floyd
Area Engr.

YUMA MILITARY AIRPORT
Yuma, Ariz.

SAN DIEGO AREA
San Diego, Calif.
Capt. Gordon A. Lilley
Area Engr.

AIRCRAFT WARNING SERVICE
San Diego, Calif.

FORT EMORY
San Diego, Calif.

FORT ROSECRANS
San Diego, Calif.

AREA IMPOT
Los Angeles, Calif.
Arthur L. Lawhead,
Admin. Asst.

CAMP LOCKET AREA
Campo, Calif.
Lt. Daniel Allen,
Area Engr.

CAMP LOCKETT
Campo, Calif.

SUB-AREA NO. 1
Baldwin Park, CA
James G. Morgan,
Asst. Area Engr.

SANTA ANITA ORDNANCE
TRAINING CENTER
Arcadia, Calif.

SANTA FE DAM
Azusa, Calif.

SUB-AREA NO. 3
Maywood, Calif.
Clarence Shadel
Asst. Area Engr.

ARMY AIR FORCES SUPPLY
DEPOT
Maywood, Calif.

SUB-AREA NO. 4
Van Nuys Gen. Hosp.
Van Nuys, Calif.
John H. Heinmiller,
Asst. Area Engr.

LOS ANGELES METROPOLITAN AREA
Los Angeles, Calif.
Frederick C. Bennett
Area Engr.

SUB-AREA NO. 2
Los Angeles, Calif.
William S. Cowart,
Asst. Area Engr.

GRAND CENTRAL AIRPORT
Glendale, Calif.

SUB-AREA NO. 5
Mines Field
Inglewood, Calif.
William L. O. Martini,
Asst. Area Engr.

NORTHROP AVIATION, INC.
Hawthorne, Calif.

NORTH AMERICAN AVIATION
INC.
Inglewood, Calif.

DOUGLAS AIRCRAFT CO.
Santa Monica, Calif.

DOUGLAS AIRCRAFT CO.
El Segundo, Calif.

SUB-AREA NO. 6
LOCKHEED AIR TERMINAL
Burbank, Calif.
Richard M. Rigney
Asst. Area Engr.

SUB-AREA NO. 8
Torrance, Calif.
Charles A. Mortensen,
Asst. Area Engr.

LOS ANGELES SUB-PORT
OF EMBARKATION HOSP.
Torrance, Calif.

SUB-PORT OF EMBARKATION
Wilmington, Calif.

WILMINGTON CLASSIFICATION YARD AND UNITED
NATIONS DEPOT
Wilmington, Calif.

HANSEN DAM
San Fernando, Calif.
Homer F. Hofriter,
Caretaker

SEPULVEDA DAM
Van Nuys, Calif.
Albert Lester,
Caretaker

SUB-AREA NO. 7
Spring St., Long
Beach, Calif.
George S. Folkard,
Asst. Area Engr.

DOUGLAS AIRCRAFT
Long Beach, Calif.

LONG BEACH AIRFIELD
Long Beach, Calif.

YULTKE AIRCRAFT
Downey, Calif.

PRADO DAM
Canyon Road
Corona, Calif.
William H. Rison
Caretaker

AREA AND FULLERTON DAMS
Fullerton, Calif.
Clarence M. Stanfield
Caretaker

ORGANIZATION CHART
DISTRICT AREA OFFICES
Los Angeles, Calif.
25 Aug 1943

LOS ANGELES, CALIFORNIA DISTRICT
751 So. Figueroa Street
DISTRICT ENGINEER
COLONEL RUFUS W. PUTNAM

EXECUTIVE OFFICER
Lt. Col. H. F. Thompson, C.E.

CONTROL OFFICER
Major E. B. Bailey, C.E.

ADMINISTRATIVE DIV.
Maj. Milburne Webb, C.E.

MILITARY ENGRG. DIV.
Lt. Col. W. J. Leen, C.E.

CIVIL ENGRG. DIV.
Guy B. Bebout

SERVICE DIVISION
Lt. Col. Henry Crown, C.E.

SANTA MARIA-CAMP COOKE AREA
Santa Maria, Ca.
Capt. Huch C. Cate,
Area Engr.

SANTA MARIA ARMY AIR BASE
Santa Maria, Ca.

CAMP COOKE
Camp Cooke, Ca.

SAN LUIS OBISPO AREA
Camp San Luis Obispo, Ca.
Capt. John R. Harris
Area Engr.

SALINAS DAM
Santa Margarita, Ca.

SAN NICOLAS ARMY AIR BASE
San Pedro, Ca.
Capt. Geo. D. McGrath
Asst. Area Engr.

LONG BEACH-SAN PEDRO AREA
San Pedro, Ca.
H. W. McOuat,
Area Engr.

FORTIFICATIONS
San Pedro, Ca.
Capt. Everett W. Watkins, Asst. Area Engr.

PIER A & BATTERIES 128 & 242
Long Beach, Ca.
Capt. Bruce W. Bennett
Asst. Area Engr.

AIR FORCE CONSTRUCTION
San Pedro, Ca.
Lt. James W. Davison
Asst. Area Engr.

FORCE ACCOUNT CONSTRUCTION
San Pedro, Ca.
Irvine R. Dunbar
Asst. Area Engr.

SEA COAST DEFENSE HOUSING
San Pedro, Ca.
Lt. Robert M. Williams
Asst. Area Engr.

MISCELLANEOUS CONSTRUCTION
San Pedro, Ca.
Capt. Lyman A. Markel
Asst. Area Engr.

KINGMAN AREA
Kingman, Ariz.
Alvin L. Saunders
Area Engr.

KINGMAN GUNNERY SCHOOL & AIRPORT
Kingman, Ariz.

NEEDLES AIRPORT
Needles, Ca.

YUCCA GUNNERY RANGE
Yucca, Ariz.
John W. Joyce
Asst. Area Engr.

V.H.F. CONSTRUCTION
San Pedro, Ca.
George C. Ellis
Asst. Area Engr.

A.W.S. CONSTRUCTION
San Pedro, Ca.
Walter J. Markel
Asst. Area Engr.

BLYTHE AREA
Blythe, Ca.
Ralph R. Ferguson
Area Engr.

BLYTHE ARMY AIRFIELD
Blythe, Ca.

PARKER RELOCATION CENTER
Poston, Ariz.

DESERT CENTER
Blythe, Ca.

RICE AIR SUPPORT BASE
Blythe, Ca.

SHAVERS SUMMIT
Blythe, Ca.

CAMP YOUNG
Blythe, Ca.

BELLEMONT AREA
Bellemont, Ariz.
Earl E. Jones
Area Engr.

NAVAJO ORDNANCE DEPOT
Bellemont, Ariz.

WINSLOW MUNICIPAL AIRPORT
Winslow, Ariz.

LAS VEGAS AREA
Las Vegas, Nev.
Capt. Herman A. Bowen
Area Engr.

LAS VEGAS GUNNERY SCHOOL
Las Vegas, Nev.

CAMP WILLISTON
Las Vegas, Nev.

INDIAN SPRINGS AUXILIARY LANDING FIELD
Indian Springs, Nev.

LOS ANGELES, CALIFORNIA DISTRICT
751 So. Figueroa Street
DISTRICT ENGINEER
COLONEL RUFUS W. PUTNAM

EXECUTIVE OFFICER
Lt. Col. H. F. Thompson, C.E.

CONTROL OFFICER
Major E. B. Bailey, C.E.

ADMINISTRATIVE DIV.
Maj. Milburne Webb, C.E.

MILITARY ENGRG. DIV.
Lt. Col. W. J. Leen, C.E.

CIVIL ENGRG. DIV.
Guy B. Bebout

SERVICE DIVISION
Lt. Col. Henry Crown, C.E.

SUB-AREA NO. 1
Arlington, Ca.
Arvid Backlund,
Asst. Area Engr.

CAMP ANZA
Arlington, Ca.
Marion A. Johnson,
Resident Engr.

MIRA LOMA Q.M. DEPOT
Mira Loma, Ca.
Alan Williams,
Resident Engr.

ONTARIO OBSERVATION AIRFORCE
Ontario, Ca.
George Ferguson,
Resident Engr.

SANTA ANA ARMY AIR BASE
Santa Ana, Ca.
Capt. C. E. G. Wikoff
Asst. Area Engr.

SAN BERNARDINO AIR DEPOT
San Bernardino, Ca.
Capt. Harry L. Foster
Asst Area Engr. (C.E.)

SAN BERNARDINO-MOHAVE AREA
San Bernardino, Ca.
Maj. Oliver H. Ochsner,
C.E., Area Engr.

SUB-AREA NO. 2
Barstown, Ca.
W. E. Westerfield,
Asst. Area Engr.

YERMO HOLDING & RECONSIGNMENT POINT
Yermo, Ca.

DAGGET MODIFICATION CENTER
Dagget, Ca.
Thomas C. Metcalf,
Resident Engr.

CAMP IRWIN, BARSTOW, CA
Gordon G. Lee,
Resident Engr.

MUROC BOMBING RANGE
Muroc Lake, Cal.
S. J. Cooke, Jr.,
Asst. Area Engr.

VICTORVILLE ARMY FLYING SCHOOL
Victorville, Ca.
Dewitt Mitcham,
Resident Engr.

SUB-AREA NO. 3
Independence, Ca.
Henry S. Warren,
Asst. Area Engr.

OWENS VALLEY RECEPTION CENTER (MANZANAR)
Independence, Ca.

BISHOP AIRPORT
Bishop, Ca.

PALM SPRINGS AIRPORT & TORNEY
Palm Springs, Ca.
Ross M. Duncan,
Asst. Area Engr.

CAMP HAAN
Riverside County, Ca.
Capt. Albert W. Morrison, Asst. Area Engr.

MARCH FIELD
Riverside County, Ca.
Frederick Johnston,
Asst. Area Engr.

PHOENIX-TUCSON AREA
Phoenix, Ariz.
Lt. Col. K.J. Harrison
Area Engr.

DAVIS-MONTHAN FIELD
Tucson, Ariz.
Bart Wooluns,
Asst. Area Engr.

DOUGLAS ARMY AIRFIELD, Douglas, AZ
1st Lt. Walter T. Jones
Asst. Area Engr.

FORT HUACHUCA
Fort Huachuca, Ariz.
Maj. A. E. Scroggs,
Asst. Area Engr.

LITCHFIELD AIRFIELD
Litchfield, Ariz.
John H. Dudley
Asst. Area Engr.

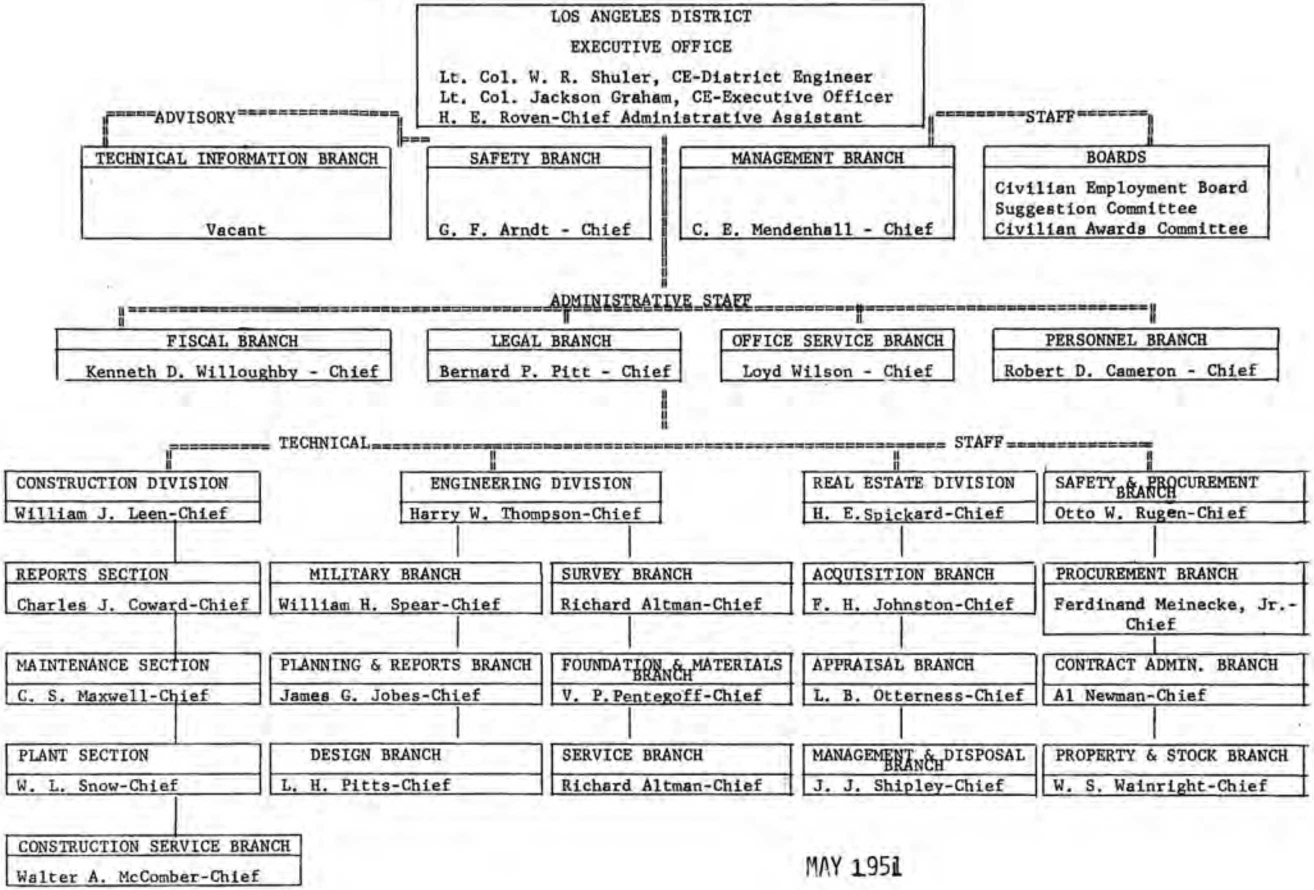
BASE YARD
Phoenix, Ariz.
Amos W. Riggs
Superintendent

COOLIDGE AUXILIARY OPERATING BASE
Coolidge, Ariz.
Earl Patterson,
Asst. Area Engr.

MARANA BASIC FLYING SCHOOL
Tucson, Ariz.
Lt. Arthur Davis,
Asst. Area Engr.

MODIFICATION CENTER NO. 2
Tucson, Ariz.
Capt. J. L. Brookbank
Asst. Area Engr.

8. Organizational Chart, LAD, May 1951.



9. Organizational Chart, LAD, August 1, 1959.

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES

EXECUTIVE OFFICE

Col. C. T. Newton, C.E.	District Engineer
Lt. Col. John R. Oswalt, Jr., C.E.	District Engineer
Lt. Col. Jack W. Fickessen, C.E.	Asst. to District Engineer
751 South Figueroa Street	Los Angeles, California

BOARDS & COMMITTEES
Standing Grievance Comm.
Incentive Awards Comm.
Board of C.S. Examiners

ADVISORY AND ADMINISTRATIVE STAFF

COMPT'S OFFICE
K.D. Willoughby, Comp
- AUDIT BRANCH — W.G. James, Chief
- BUDGET BRANCH — S.T. Johnson, Chief
- FINANCE & ACCTG. BR. — L.E. Oliver, Chief
- MANAGEMENT BRANCH — R.C. Simpson, Chief
- PROPERTY ACCTG. BR. — W.D. Freedman, Chief

TECH. LIASON BR.
M.F. Ryan, Chief
- SECURITY BRANCH — C.D. Daniel, Chf.

SAFETY BRANCH
G.F. Arndt, Chief

LEGAL BRANCH
J.S. Greenfield, Chief

PERSONNEL BRANCH
H.M. Berger, Chief
- CLASSIFICATION & WAGE SECTION — T.H. Thar[illegible]lson, Chf.
- EMPLOYEE UTILIZATION SECTION — J.G. Loomis, Chief
- ADMINISTRATIVE SECTION — Ms. B.M. Reynolds, Chf

OFFICE SERVICE BRANCH
J.A. Thomas, Chief
- MAIL & RECORDS SECTION — Mrs. A.C. Davis, Chief
- REPRODUCTION SECTION — R. Lamori, Chief
- GEN. SERVICE SECTION — R. Samoreno, Chief
- RECORDS MANGT. SECTION — Ms. H.G. Swanson, Chief
- OFFICE SUPPLIES & EQUIP. SECTION — Mrs. E.V. Olson, Chief

TECHNICAL STAFF

CONSTRUCTION DIVISION
W.J. Leen, Chief
R. McKenzie, Asst.
- CONSTRUCTION SERV. BR. — R. McKenzie, Chief
- REPORTS BRANCH — C. J. Caward, Chief
- OPERATIONS BRANCH — W.S. Wainright, Chief

ENGINEERING DIVISION
H.W. Thompson, Chief
J. G. Jobes, Asst.
- ELECTRONIC DATE PROCESSING BRANCH — W. C. Laidlaw, Chief
- DESIGN BRANCH — E. Koehm, Chief
- FOUNDATION & MATERIALS BRANCH — V. P. Pentegoff, Chief
- MILITARY BRANCH — J. P. Hatteberg, Chief
- PLANNING & REPORTS BRANCH — S. F. Cramer, Chief
- SURVEY BRANCH — T. O. Molloy, Chief
- PROGRAM DEVELOPMENT — R. Altman, Chief

REAL ESTATE
J. J. Shipley, Chief
- ACQUISITION BRANCH — W. M. Curran, Jr., Chief
- APPRAISAL BRANCH — D. R. Keene, Chief
- MANAGEMENT & DISPOSAL BRANCH — L.B. Otterness, Chief
- PLANNING & CONTROL BRANCH — J. Houston, Chief

SUPPLY DIVISION
E.A. Lusk, Chief
- PROCUREMENT BRANCH — V.M. Morgan, Chief
- CONTRACT ADMINISTRATION BRANCH — R. Amundson, Chief
- SUPPLY CONTROL & DISTRIBUTION BRANCH — H. F. Guenther, Chief

1 August 1959

APPROVED:
(Signed) C. T. Newton, Col., C.E.
District Engineer

- SAN ANTONIO-CHINO (C)
  D.W. Ralston, Proj. Engr.
- SANTA CLARA RIVER
  P.D. Foley, Proj. Engr.
- RUBIO WASH (C)
  JET PROPULSION (M)
  CARBON CANYON (C)
  W.J. Robinson, Proj. Engr.
- NORAD (M)
  R.L. Coker, Proj. Engr.
- LA DEFENSE AREA SITES (M)
  T. Bates, Proj. Engr.

- EDWARDS AFB (M)
  EDWARDS AUX #1 (M)
  AC&W SITE, P-59
  BORON, CALIF. (M)
  PALMDALE AF PLANT #2 (M)
  G.P. Davis, Proj. Engr.
- LA RIVER (C)
  F. Childs, Proj. Engr.
- GEORGE AFB (M)
  L.A. Daugherty, Proj. Engr.
- MARCH AFB (M)
  NORTON AFB (M)
  USARTC, SAN BERNARDINO (M)
  B.C. Hedrick, Proj. Engr.

- MORTON SAGE (M)
  H.F. Althaus, Proj. Engr.
- SAN GABRIEL VALLEY FLOOD CONTROL
  L.G. Hogue, Proj. Engr.
- SAWTELLE-WESTWOOD (C)
  B.W. Bennett, Proj. Engr.
- PLAYA DEL REY (C)
  A.R. Ross, Proj. Engr.

- ARIZONA AREA OFFICE
  *W.S. Alldredge, Area Engr.
- LUKE AFB (M)
  LUKE SAGE (M)
  E.K. Hultberg, Proj. Engr.
- PAINTED ROCK (C)
  D.G. Putnam, Proj. Engr.
- WILLIAMS AFT (M)
  J.J. Sheehey, Proj. Engr.
- FORT HUACHUCA (M)
  G.T. Ankrom, Proj. Engr.
- TUCSON PROJECT (M)
  V.V. Buschmeyer, Proj. Engr.
- WHITLOW RANCH (C)
  O.B. Anderson, Proj. Engr.
- YUMA PROJECT (M)
  *W.S. Alldredge, Proj. Engr.

- WESTERN AREA OFFICE
  Lt. Col. A.W. Sanders, Jr., Area Engr.
- FLOOD CONTROL (C)
  J.A. Wahler, Proj Engr.
- TECHNICAL FACILITIES GENERAL (M)
  C.W. Yockers, Proj. Engr
- 65 LAUNCH FACILITIES (M)
  C.N. Zleisy, Proj Engr.
- 68 LAUNCH FACILITIES (M)
  B. Smiddy, Proj Engr.
- SUPPORT FACILITIES (M)
  W.V. Starrett, Proj. Engr.

*Dual Assignment

10. Organizational Chart, LAD, August 1, 1965.

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES

EXECUTIVE OFFICE

Col. John A. B. Dillard, CE — District Engineer
Maj. Robert T. Ojendyk, CE — Dept. Dist. Engineer
300 N. Los Angeles Street
Los Angeles, California 90012 — 688-2000

SPEC. ASST.
F.W. McGregor
Spec.Asst. to Dist. Engr.for Utah

SPEC. ASST.
Wm.S. Alldredge
Spec. Asst. to Dist. Engr. for Ariz. & Nev.

BOARDS & COMMITTEES
Incentive Awards Committee

ADVISORY AND ADMINISTRATIVE STAFF

COMPT'S OFFICE
Leo E. Oliver,Compt
- AUDIT BRANCH — W. G. James,Chief
- BUDGET BRANCH — M.P. Bentz,Chief
- FIN. & ACCTG. BR. — G.A. Foerst, Chief
- MANAGEMENT BR. — R.C. Simpson,Chief
- PROP. ACCTG. BR. — W.D. Freedman,Chief

TECH. LIAISON OFF.
M. F. Ryan,Chief
- SECURITY & EMERGENCY PLANNING OFFICE — C.D. Daniel,Chief

SAFETY OFFICE
G.F. Arndt,Chief

OFFICE OF COUNSEL
J.S. Greenfield, Dist. Council
- AUTOMATIC DATA PROCESSING CENTR. — Vacancy, Chief; *J.W. Gebhart, Acting Chief

PERSONNEL
H.M. Berger,Chief
- PERSONNEL MGT. ASSIST. BRANCH — *J.G.Loomis,Chief
- EMPLOYMENT & SERVICES BRANCH — *J.G. Loomis,Chief
- POSITION & PAY MANAGEMENT BRANCH — T. Tharalson,Chief
- TRAINING & DEVELOPMENT BRANCH — Vacancy, Chief

ADMIN. SERVICES
J. A. Thomas,Chief
- MAIL & RECORDS BRANCH — Sage M. Bense,Chief
- RECORDS MGT. BRANCH — H.C. Swanson,Chief
- GEN. SERVICE BRANCH — R. Samoreno, Chief
- REPRODUCTION BRANCH — R. Lamori, Chief

TECHNICAL STAFF

CONSTRUCTION DIVISION
W. J. Leen, Chief
*G. A. Lilley, Asst.
- CONSTRUCTION SERVICE BRANCH — *G. A. Lilley, Chief
- OPERATIONS BRANCH — F. E. Tatum, Chief

ENGINEERING DIVISION
Edward Koehm, Chief
Lee R. Henning, Asst.
- DESIGN BRANCH — Frederick R. Cline, Chief
- FOUNDATIONS & MATERIALS — J. M. Bird, Chief
- COASTAL ENGRG. BRANCH — W. J. Herron, Jr., Chief
- PROJECT PLANNING BRANCH — S. F. Cramer, Chief
- PROGRAM DEVLPT. BRANCH — J. C. Bloodworth, Chief
- MILITARY BRANCH — J.P. Hatteberg,Chief

SERVICE BRANCH
*J. W. Gerhart, Chief

REAL ESTATE DIVISION
A. D. Stanely, Chief
- ACQUISITION BRANCH — L. J. Perry, Chief
- APPRAISAL BRANCH — D. R. Keene, Chief
- MANAGEMENT & DISPOSAL BRANCH — Vacancy, Chief
- PLANNING & CONTROL BRANCH — J. Houston, Chief

SUPPLY DIVISION
J. H. Gould, Chief
- PROCUREMENT BRANCH — J. F. McCullough, Chief
- CONTRACT ADMINISTRATION BRANCH — *F. N. Consbruck, Chief
- SUPPLY CONTROL & DISTRIBUTION BRANCH — W. F. McCauley, Chief

*Dual Assignment

1 August 1965

APPROVED:
(Signed) JOHN A. B. DILLARD,COL
District Engineer

FT. IRWIN PROJECT (M) R.L. Coker, Proj. Engr.	GEORGE AFB PROJECT (M) R. L. Hansen Proj. Engr.	FT. HUACHUCA PROJECT (M) V.C. Buschmeyer Proj. Engr.	LAS VEGAS PROJECT (M) H. F. Althaus Proj. Engr.	ALAMO DAM PROJECT (C) A. B. Madinger Proj. Engr.	EDWARDS AFB RESIDENT (M) J. W. Hamilton Resident Engr.	WESTERN AREA (M) (C) Lt.Col.R.W. Patterson Area Engr.
TUCSON PROJECT (M) (C) W.W. Zimmerman Proj. Engr.	MARCH AFB PROJECT (M) E.K. Hultberg Proj. Engr.	L.A. DEFENSE PROJECT (M) R. L. Primera Proj. Engr.	COYOTE CREEK PROJECT (C) C. S. Burrell Proj. Engr.	JPL PROJECT(M) K. E. Renham Proj. Engr.		
SAN GABRIEL RIVER PROJ.(C) D. W. Ralston Proj. Engr.	VENTURA HARBOR PROJECT (C) H. W. Rognlie Project Engr.	LAWNDALE PROJECT (M) D. C. Delimont Proj. Engr.	PHOENIX PROJECT (M) C. D. Raines Proj. Engr.			

BIBLIOGRAPHY

The most valuable materials for this study of the Los Angeles District, Army Corps of Engineers, are drawn from project reports filed in the Mail and Records Reports Library, printed public documents located in the District Library, taped interviews with key personnel which are on file in the Public Affairs Office, and speeches and articles which were produced by District personnel and which are on file in the Public Affairs Office or other elements of the Los Angeles District.

General

I. Primary Sources

A. Reports, Speeches, Drafts of Articles, and Other Material by District or Corps of Engineers Personnel.

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CHAPTER TWO

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Any study of the major harbors in southern California relies heavily on the works of former employees, particularly D. E. Hughes, H. W. McOuat, N. E. Parker, William J. Herron, Jr., as well as the reports of innumerable District Engineers. Perhaps the key report is the one prepared in 1939 which contained a review of prior reports of the Los Angeles and Long Beach Harbors. For the period 1852 to 1914, this study utilized government documents, but for the period since 1914 major sources of materials were drawn from the Mail and Records Reports Library.

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3. Letter from K. H. Wade, General Manager, Southern California Railway Company.

4. Letter and memorandum from W. R. Corson.

5. Letter from Capt. A. A. Polhamus.

6. Letter from Capt. E. Alexander.

7. Letter from Capt. J. A. Muir.

8. Memorandum by Prof. Davidson, U.S. Coast and Geodetic Survey.

9. Letter from William Hood, Chief Engineer, Southern Pacific Company.

10. Letter from William Hood, Chief Engineer, Southern Pacific Company, submitting memorandum by Commander Taylor, U.S. Navy.

11. Letter from W. D. Gelette, submitted by William Hood, Chief Engineer, Southern Pacific Company.

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CHAPTER THREE

Particularly valuable as references on the development of small boat harbors are the items listed in Section A of the following bibliography. Important from a coastal engineering standpoint are the bibliographical items for Marina del Rey, Redondo Beach, Mission Bay (San Diego), and Dana Point Harbors, for they contain significant knowledge concerning the construction and placement of small craft harbors. For sources on the Colorado River refer to the items in Chapter One.

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CHAPTER FIVE

Flood Control

The amount of source material available on flood control demonstrates the importance of this aspect of the civil works mission of the Los Angeles District since 1935. The preliminary examination reports contain a vast amount of information, especially the inclosures which have significant materials like historical photographs, transcripts of public hearings, studies by engineering consultants, as well as engineering data. Evidence of public interest in flood control also is indicated by the number of addresses and articles by personnel of the Los Angeles District and other elements of the Corps of Engineers. The bulk of the items consulted also provide source material for Chapter VI on Water Resources, for changes in policies by Congress shifted emphasis from single purpose projects to multiple purpose ones.

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CHAPTER SIX

Water Resources

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CHAPTER SEVEN

Military Role

In contrast to civil works, documents for the military mission are not only more difficult to obtain but also are more technical in nature. As a result, this chapter relied more on the speeches and articles of members of the Los Angeles District. Fortunately, district engineers had historical consciousness which eased the task of recapturing the record of military construction. The documents available in the Mail and Records Reports Library and in holding areas illustrate how the District carried out its military function. The documents in Mail and Records are of recent origin, for after 6 years documents on military construction are transferred to designated holding areas. The present depository for the District is the Federal Records Center, GSA, Bell, California 90201. The earlier one is at Kansas City, Missouri. The Records Management Branch, LAD, maintains a list of the transferred holdings.

Thus, documents relating to military construction, with emphasis on basis for design, design analysis and estimate, outline specifications and estimates, control estimates, and other contract data, are available at the Federal Records Center, Bell, California, for facilities at many of the military installations within the Los Angeles District.

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INDEX

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